THE *Petroleum* Engineer — Management Edition

Exploration—Drilling—Producing • Refining—Petrochemicals—Gas Processing • Oil and Gas Pipelining

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Drilling at Piadena, Italy — ENI Photo

COURSE OF OIL

What Does the Price of Oil Cover?

In Europe – which owes more to oil than to any other one industry for its economic recovery since World War II – there is presently dissatisfaction with the price of crude oil. A proposal to fix what is termed "right" prices is made by a UN report, which is inspiring newspaper headlines in Europe but seems to be restricted in the United States.

What should *the price of oil cover?*

The answer to that question is bigger than the oil industry. The answer involves freedom and slavery. If the price of oil is not to cover the billions spent every year on geological parties in Costa Rica and seismic crews in Somaliland – on the drilling operations in Cuba and in Sicily – on new refineries in the Philippines and in Aden – on new pipe lines in Canada and Sumatra – on new filling stations in Germany and Japan – If the price of oil does not cover these operations and facilities, then tax-supported governments must take over and/or we'll do with less and less oil until present reserves are depleted and the world grows dark again.

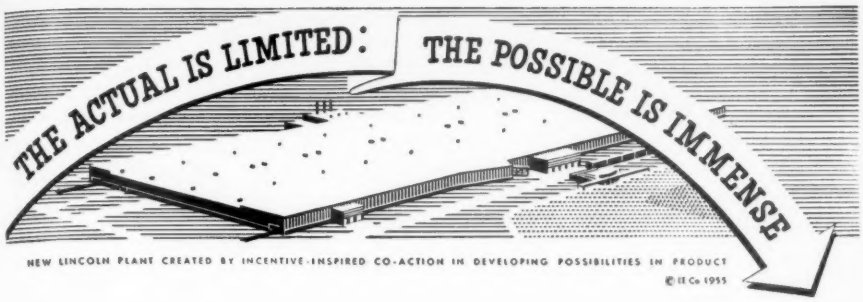
What should *the price of oil cover?*

Should it cover only the cost of producing a fabulous find like Kuwait? Then who shall pay for the fabulous failures? Who shall pay the billions in capital needed to find future supplies that may lie hidden in the Continental Shelf off U. S. shores or along the seacoast of Brunei – or in the deserts of Egypt or the hinderlands of Australia?

Of course it is the consumer who must pay if he and the international oil industry are to remain free. The price of oil must cover the expenses of the oil industry or be subsidized.

No one can place a "right" price on oil – it is priceless. It is lifting the human race from darkness and drudgery and hunger and immobility as its use increases in the four corners of the earth. When the industry is allowed freedom – freedom to work and to let the price of its work be set in the market place – the supply is always there and the price is always cheap.

Ernestine Adams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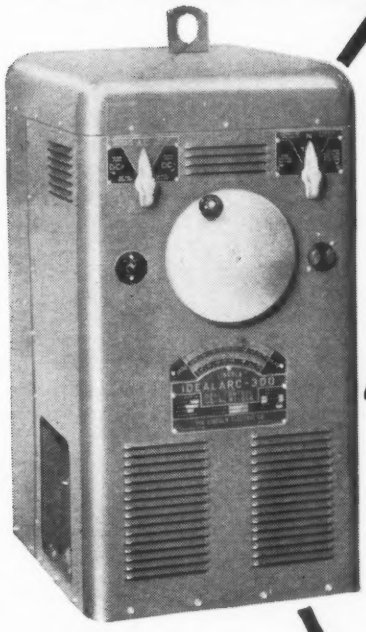

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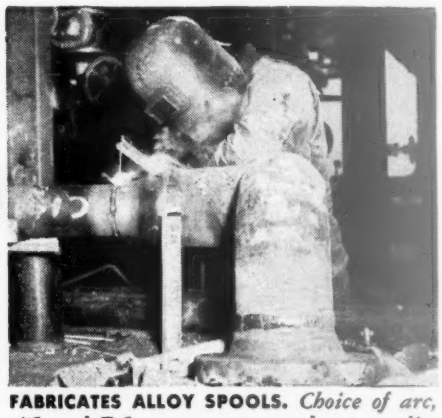

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HIGHLIGHTS ★ ★ ★

Digest of News and Comment

Oil stocks on hand continue to shrink, even though refinery runs remain high. Fuel demand, although aided by cold weather, rode along with high retail sales and automotive sales to establish a record nearly 10 per cent above last year's first quarter.

★ ★ ★

Federal highway programming hit two new snags concerning toll roads and methods of financing. The administration's vindication of toll roads has met with disapproval of the National Oil Jobbers Council on the grounds that licensing of concessionaires along toll roads would be a bar to free enterprise, and tend toward state monopolies. Oregon senators are suggesting a three cent gasoline tax, instead of present two cent levy, while others are calling for complete abolition of the levy. One scheme for raising the $20,000,000 through three per cent government bonds, has been labeled a giveaway.

★ ★ ★

Power, oil and gas receipts may eventually make the Interior Department self-sustaining, according to its secretary, Douglas McKay. The department has made a bid for a federal appropriation of $424,461,000 for the coming fiscal year. Outer shelf tidelands along Louisiana and Texas Gulf Coast will bring in a total of $6,000,000,000 in rentals, bonuses and royalties, McKay told the appropriations committee.

★ ★ ★

Texas Railroad Commission has trimmed almost 60,000 bbl daily from the state's production allowable for a daily run of 3,275,074 bbl through the month of April. Most Texas fields will be placed on a 17-day producing schedule.

★ ★ ★

Socony-Vacuum will assume the role of contractor in exploratory activity in Portugal, with a working interest on rights held by Companhia dos Petroleos de Portugal. This company is controlled largely by the Portuguese government and the Axel Johnson interests of Stockholm. Activities of the American company will be carried on under the recently organized Socony-Vacuum Exploration Company with headquarters in Lisbon.

★ ★ ★

Esso Standard, S.A.F. (Jersey Standard and Gulf) will establish a new organization to develop existing production and exploit new areas in France. The subsidiary will bear the name Societe Esso de Recherches et d'Exploitation Petroliere. It was recently announced that the American company's Esso No. 1, Parentis field, was completed with a daily potential of 3500 bbl per day.

★ ★ ★

American Republics Corporation-Sinclair Oil Corporation merger may not have been the largest in history, but it may have carried the most weight, literally. The transaction, concluded March 23, involved signing some 12,000 documents weighing an estimated three or four tons.

★ ★ ★

President Eisenhower cautioned observers that the cabinet committee report on fuels recently presented does not as yet have his blanket approval. Most provocative section suggested that the Federal Power Commission's authority to regulate the sale of natural gas by independent producers be removed. The President may await the outcome of pending congressional action, before taking a stand on the controversial issue.

★ ★ ★

North Dakota's April crude allowable has been set at 23,885 bbl per day, a decrease from last month's proration of 33,559. The April figure represents only about 8 bbl per day per well.

★ ★ ★

Oklahoma crude allowable for April has been cut back about 10,000 bbl per day by the state commission. In southern Oklahoma fields purchasers have been taking only 65 to 80 per cent of the allowed runs for the past few months. Although the March allowable set was 575,000 bbl, average run was 559,950 bbl.

Quoted on two occasions, Socony-Vacuum says it will cut back its crude imports, starting at 5000 bbl in May and gradually working downward to 16,000 bbl daily less than present level. The voluntary cut will be made effective through elimination of import increases scheduled to come from Canada to the company's Ferndale, Washington, refinery.

★ ★ ★

Gulf Oil Corporation produced more and more oil products—and earned more money doing it—than in any previous year. Net crude production averaged 763,200 bbl daily, with the company collecting some $1,705,328,795 from sales and operating revenue, and showing a net income of $182,813,045. On per share basis, Gulf netted $7.16 as compared with $6.86 per share in 1953.

★ ★ ★

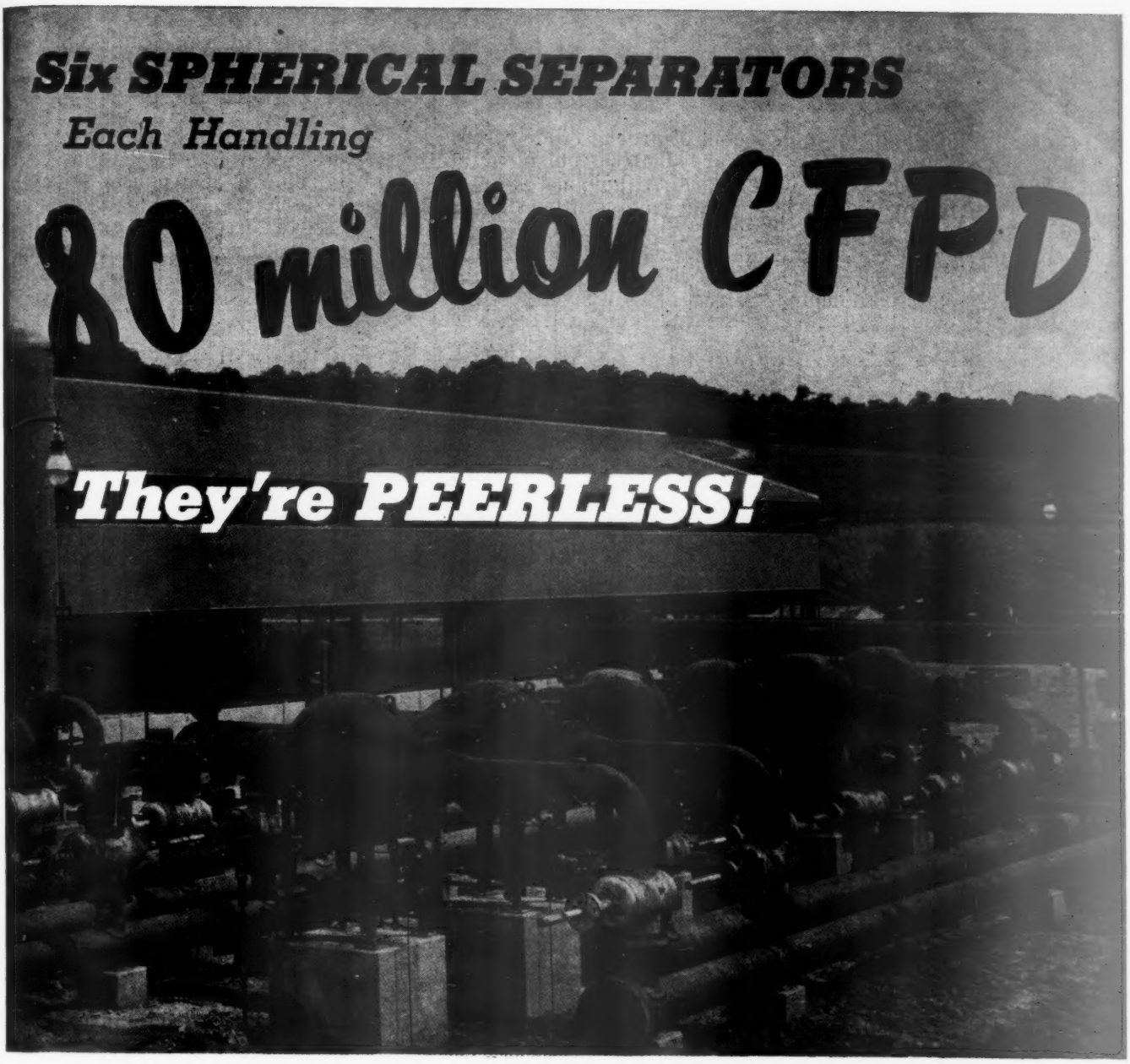
University of Oklahoma's school of petroleum engineering is inviting application for five graduate fellowships available next year. Offering stipends ranging from $1500 to $1600 are Humble, Stanolind, Sinclair, Shell, and Lane Wells. Applications must be made by April 15.

★ ★ ★

FPC admits that it wants no part in trying to regulate natural gas producers, according to testimony given by the power commission chairman Kuykendall before the House commerce committee. Among reasons given, Kuykendall cited that Supreme Court had singled out one mining operation for federal control, that artificially fixed prices could exhaust gas supply prematurely, and that public utility regulation has never been sufficient incentive for economy of operation.

★ ★ ★

Socony-Vacuum has raised wholesale gasoline prices as much as two cents per gallon to dealers in parts of Massachusetts, Rhode Island and Connecticut. Socony also raised dealer's prices in New Jersey one cent a gallon following similar boosts by Esso and Gulf. Retailers in this state have upped prices on all grades of gasoline as much as seven cents per gallon.



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REPRESENTATIVES IN ALL PRINCIPAL CITIES

Texas oil man Hugh Roy Cullen claims he has given away 93 per cent of his worldy goods. University of Houston has received $11,000,000 of the fortune, along with oil leases and royalties. Exaggerations about his gifts to the college, Cullen said, have given a false impression about the school's financial solidarity.

★ ★ ★

Federal court order has dimmed any hopes of six railroads to lower freight rates on petroleum products in the Pacific Northwest. An injunction has been in effect to stave off lower rate allowed by Interstate Commerce Commission order issued late in 1953. Rate would have rendered pipelines, barges, and trucking impractical.

★ ★ ★

Long-awaited release of the presidential report on fuels and resources has set legislative wheels grinding. Most of the report has met with approval in the oil industry, although the suggestions concerning imports failed to please many — too mild for independents, too pointed for the internationals.

★ ★ ★

"If you can't fight them — join them" attitude has been accepted by the Southern Pacific Company. The railroad, first to build a major pipeline, will lay oil products lines from Los Angeles to Phoenix and Phoenix to El Paso. Standard of California is already interested in use of the line.

★ ★ ★

Effect of fuel and resources report to Eisenhower concerning voluntary crude import restrictions has been a cut back by several of the majors. So far, Gulf, Jersey Standard and Standard of California have announced imports reductions. California Standard will trim its imports by 11,000 bbl per day, while Jersey Standard will bring in "a little less," and Gulf "will go along with the others."

★ ★ ★

For the last 11 years, liquid hydrocarbon reserves in the United States have been increased to reach a high of 34,804,000,000 bbl. This figure represents 29,560,000,000 bbl of proved crude reserves and 5,244,000,000 bbl of natural gas liquid. Although Texas and California, representing the largest oil stockpiles, registered decreases from 1953 totals, Oklahoma and Louisiana have shown substantial gain from new discoveries, field extensions and revisions.

★ ★ ★

Congressman Heselton of Massachusetts has assumed the lead in opposing exemption of natural gas producers from federal regulation on the grounds that: "The 25 million odd gas consumers whose rates were increased over the last five years by about $200,000,000 are interested in some protection assuring reasonable rates and fair profits." Heselton is presenting two bills in opposition to two others asking Congress to nullify Supreme Court ruling.

★ ★ ★

Saudi Arabian government has granted an American company, International Development Services, exclusive rights to petrochemical development from excess natural gas from oil production in Arabia. Government would share in profits equally.

★ ★ ★

State legislation to open up oil drilling on California-owned tidelands has been endorsed by State Finance Director John M. Peirce. The official estimated that California had more than 4 billion barrels of oil under submerged lands, which would yield the state $2.5 billion in revenue.

★ ★ ★

Wage increases averaging 10 cents per hour have been the trend this past month. Magnolia, Continental, Humble, Esso Standard, Standard of California, Atlantic and others have made increases. Although non-union and independents are accepting the raise, some larger unions are holding out for more.

★ ★ ★

Seven natural gas companies have returned $14,691,814 to wholesale companies under government advisement. Most of the amount is result of Supreme Court's invalidation of a Texas tax on gas gathering.

Jersey Standard has formed a company with Italian interests to be known as Augusta Ricerche Petrolifere, S. F. A., to drill for oil in Sicily. First exploratory well is scheduled around May 1 on one of three tracts totaling 215,000 acres.

★ ★ ★

Newly organized Oil, Chemical and Atomic Workers International (CIO) is hunting for 800,000 members from oil and chemical industries. Present strength is less than 200,000. Union was formed by merger of CIO's Oil Workers' International Union and the United Gas, Coke and Chemical Workers' Unions.

★ ★ ★

Although eleven companies have been approved to buy a portion of the five per cent oil consortium set aside for American independents in Iran — question of who gets how much must be settled. Each company has expressed a desire for one to five per cent, or all the allotted amount.

★ ★ ★

Oil companies involved in international trade are under fire by British newspapers as price fixers. Uproar began with United Nations report on "Price of Oil in Western Europe," claiming that Middle East oil prices are linked with those in the United States and suggesting that prices be fixed by governments.

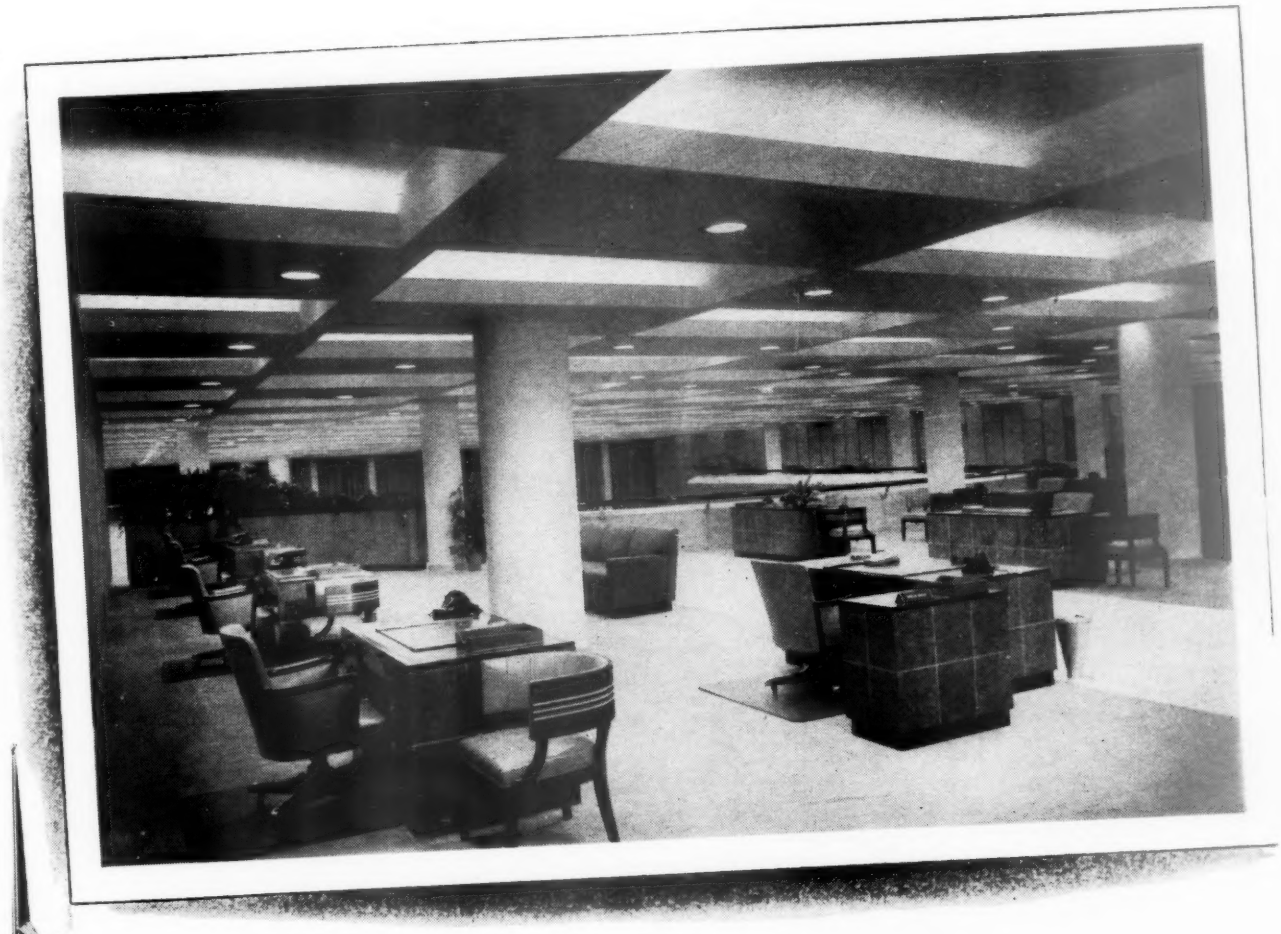
★ ★ ★

Although twenty-odd synthetic rubber plants were sold recently by the government without a hitch, the remaining three are calling for new legislation to reopen bidding. A bill introduced by Texas senators, which would attempt to dispose of Baytown, Texas, plant is meeting with stiff opposition. The one bid submitted was rejected as too low.

★ ★ ★

Intrastate trucking hearing has been reset by the Interstate Commerce Commission for June 13. Time will be allowed to "any interesting party" without reservation. It has been proposed that the agency assume jurisdiction over truckers hauling products from pipeline and marine terminals.

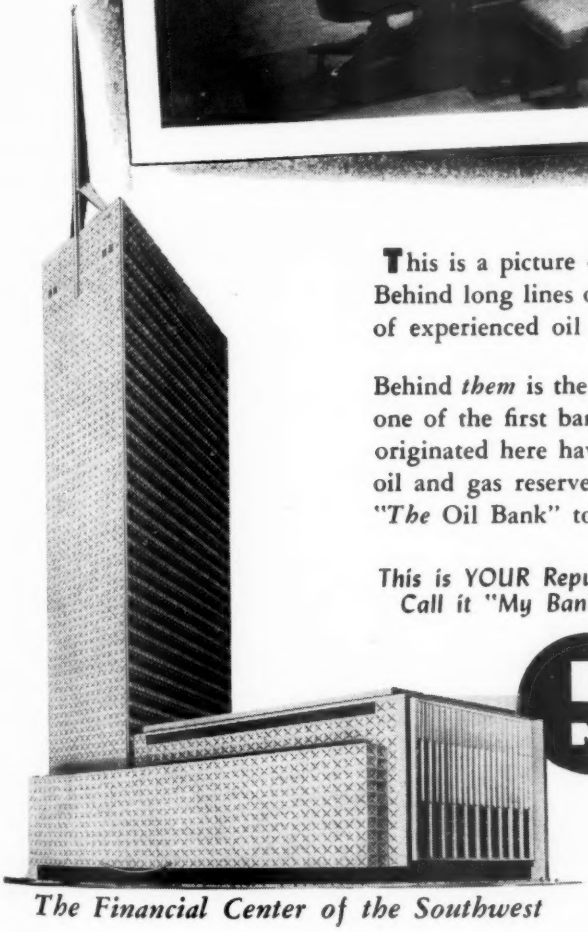
WHERE OIL WELLS BEGIN . . .



This is a picture of a part of the Oil Department at Republic. Behind long lines of doors to the right and left is a complete staff of experienced oil men, engineers and geologists.

Behind *them* is the financial strength and the oil "know-how" of one of the first banks to make Oil Production Loans. Production loans originated here have helped add billions of barrels to the nation's oil and gas reserves — and have made the Republic "*The* Oil Bank" to oil men all over America.

This is YOUR Republic
Call it "My Bank"



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Petroleum Profile

Jack A. Crichton
Oil Man

At the age when most young men are getting started in the climb to success, 38-year-old Jack Crichton of Dallas, Texas, is near the top. He is president and director of Oil and Gas Property Management, Inc., and of Empire Oil and Gas Management, Inc., Dallas and New York, and vice president of Empire Trust Company, New York.

If ever a man were destined for a career in oil, it was Jack Alston Crichton. He was born on a large plantation in Crichton, Louisiana, which had been in his family since 1870. It was producing oil before he was born.

From infancy he hob-nobbed with successful oil men, and his early inclination toward the profession had the backing of family and friends. One of these, N. C. McGowen, president of United Gas Corporation, United Gas Pipe Line Company, and Union Producing, encouraged young Crichton to enroll in Texas A&M College and study petroleum engineering.

Jack arrived at the military school in the fall of 1933. He was 16 years old, a little over five feet tall, and weighed 110 pounds. "They tell me," he recalls, "that there was one man in the freshman class smaller than I was. I don't remember him."

Encouraged by the entire sophomore class who assured him that he had a great future as an athlete, Jack went out for wrestling. In the first few seconds of his initial bout his opponent tossed him out of the ring and broke his collar bone. Jack has no doubt now that this was a move on the part of the sophomores to rid their beloved school of the scrawny freshman from Louisiana.

But Jack doesn't give up easily. He switched his athletic enthusiasm to basketball, cross country, and tennis, stayed around to play on the varsity in all three sports and gain himself the nickname of "Teal" from the swift and tricky teal duck — and rack up a shelfful of tennis trophies. He also earned a wide assortment of scholastic and military honors.

In the fall of 1937, with a degree in petroleum engineering, Jack entered Massachusetts Institute of Technology. One year later he took his master's degree in the same subject with a minor in geology. During his pre-graduate days, Jack had worked as a swamper with a Shreveport, Louisiana, drilling contractor. When he finished MIT, he joined Union Producing as a geologist.

From 1941 to 1946 Jack Crichton took a four-year leave-of-absence from the oil business to help fight the war. In 1946 he joined DeGolyer and MacNaughton as a petroleum geologist and engineer. He was elected a vice president and director of the firm in 1950 and one year later resigned to help organize the San Juan Oil Company, of which he was vice president and a director.

His present position as president and director of Oil and Gas Property Management makes him a BIG oil operator. His company has interests in 1070 wells, producing 6500 bbl of oil and 80,000,000 cu ft of gas daily. The company headquarters in Dallas, maintains offices in Houston and Amarillo, employs some 160 people. Empire Oil and Gas Management, of which he is also president and a director, is a management and consulting firm that manages properties for other owners, advises concerning engineering and geological matters and the acquisition of oil and gas properties.

Jack Crichton is a member of the American Institute of Mining and Metallurgical Engineers, American Association of Petroleum Geologists, Texas Society of Professional Engineers, Dallas Geological Society, Dallas Petroleum Engineers Club, Dallas Geophysical Society, and the Engineers Club of Dallas. He has at some time during the past five years, been an officer in most of these organizations. He is a member of Tau Beta Pi, Sigma Alpha Epsilon, and the River Club of New York, and was awarded a professional degree from Texas A&M.

Petroleum engineering takes a back seat when Jack goes home to 7019 Pasadena in Dallas. There his two girls, Marilyn Berry Crichton, whom he married in 1952, and their year-and-a-half-old Anne Alston are the real queens of his universe.

It would seem that he has just about climbed to the top of the ladder of success, but if there are any higher rungs, you can count on Jack Crichton to find them — and conquer them.

Exploration, Drilling, Producing

Production for Canadian

Canada's largest all-Canadian oil company is organizing a production department, with headquarters in Calgary, Canada. Primarily a marketing and refining company, Canadian Oil Companies, Limited, is the last of the large Canadian companies to enter this phase of the oil industry.

★ ★ ★

Signal Grant

Stanford School of Engineering has received a $10,000 grant from Signal Oil and Gas Company for special study of peacetime nuclear energy and its relation to the oil industry, the school recently announced.

★ ★ ★

Field Conference

Four Corners Geological Society is opening its doors this year to include geologists and students for its first field conference June 15-17. The society's guests will move through the San Juan and Paradox Basins in Colorado, New Mexico, Utah, and Black Mesa areas in Arizona in glass-topped sight seeing busses.

★ ★ ★

Texas Tech Course

Texas Technological College's petroleum engineering department is expecting over 500 at its annual West Texas Short Course on Oil Lifting Methods meeting at Lubbock April 21-22. More than 30 papers will be presented at the course.

★ ★ ★

Big Chief Sells Production

Big Chief Drilling Company, Oklahoma City, Oklahoma, has sold its production and leases in West Texas to the General American Oil Company, Dallas, Texas. Involved in the sale were 85 producing wells, with reserves estimated at 1,500,000 bbl of oil.

★ ★ ★

"Safety and the Driller"

American Association of Drilling Contractors has announced a new 61-page booklet, "Safety and the Driller" emphasizing the importance of the driller and his responsibility to his crew and the rig owner, as regards to safety.

★ ★ ★

Income Tax Rulings

The Internal Revenue Service ruled in March that partnership in a drilling contracting firm has no relationship to the oil and gas production activities of the taxpayer, individually (55-121). In ruling 55-118, the service held that rentals paid or accrued on non-producing oil and gas leases may be capitalized as carrying charges on unimproved or unproductive real property without regard to how such charges were filed in previous years for the same lease.

★ ★ ★

Indians Get Lease Money

More than 5000 members of the Blackfeet tribe of Montana are dividing $340,000 of funds resulting from oil and gas lease dividends.

★ ★ ★

Louisiana Order

Louisiana conservation department has released an order requiring that before any well is perforated, drilling fluid shall be brought to a weight necessary to hold normal hydrostatic pressure with margin of safety.

★ ★ ★

Cease-Flare Order

On recommendation of various producers in the Clareton field area, the Wyoming oil and gas commission issued an order shutting down oil wells producing more than 5000 cu ft of natural gas per barrel of oil. It is hoped that conservation of the 30,000,000 to 50,000,000 cu ft of gas flared daily will hasten construction of a natural gas plant near Newcastle, Wyoming.

Jamaica Gets Wildcat

Base Metals Mining Corporation, Ltd., of Canada has announced that drilling has begun on the first oil well in Jamaica. The corporation has sole prospecting rights in Jamaica and territorial waters, although United States oil companys are negotiating for exploration rights in surrounding islands. Reports are that the Texas Company may get rights to nearby Turks Islands.

★ ★ ★

Lion Comes to Liberal

Production and exploration division of Lion Oil Company has established a new district in Liberal, Kansas, handling activities in parts of southeast Colorado, the Oklahoma Panhandle and the southwestern part of Kansas. Jack V. Newman and Glenn F. Thomas will head the office.

★ ★ ★

Pressure Problems

Agitation for API standards for well-head end connections designed for working pressures up to 15,000 psi was encouraged by C. H. Taylor, Shell Oil, before American Petroleum Institute's production meeting in New Orleans, Louisiana. The industry is required to contain extremely high pressures found in Gulf Coast deep wells with growing frequency.

First oil well drilled in the Province of Alberta, Canada. It was drilled in 1902 at Waterton Lakes.

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LETTERS ★

"Red Tape" Draws Comment

We would like a quotation on reprint of 100 copies of the article, "Red Tape Can Choke Interstate Gas Sales," by Ernestine Adams, carried in the March, 1955, issue of *The Petroleum Engineer*. We consider the article very timely and applicable to our situation.

F. S. Workman, Jr.

Pond Fork Oil & Gas Company
Charleston, West Virginia

★ ★ ★

The article "Red Tape Can Choke Interstate Gas Sales" in March issue of *The Petroleum Engineer*, written by Ernestine Adams, is very good.

It seems to me that if someone would sponsor the printing of a quantity of copies and mailing of one of each to each Senator and Congressman in our national congress, it would help in getting rid of the regulation now in force.

E. L. Dawson

Kewanee Oil Company
Wirt, Oklahoma

★ ★ ★

That was indeed a dandy article on the red tape generated by federal control of natural gas. I am sure it will be brought to the attention of some of our congressmen and others, and I hope that they will get the opportunity to read it.

Charles E. Simons

General Gas Committee
Fort Worth, Texas

★ ★ ★

Congratulations on your fine article entitled, "Red Tape Can Choke Interstate Gas Sales." You have certainly approached the problem correctly from a producer's standpoint and have presented our case very realistically.

Jake L. Hamon

Dallas, Texas

★ ★ ★

Once again, you have come forth with an excellent article! I refer to "Red Tape Can Choke Interstate Gas Sales," which is very well done and should be of great benefit to us.

Frank M. Porter

American Petroleum Institute
New York, N.Y.

Drainhole Drilling Articles

The March issue of *The Petroleum Engineer* concluded a series of articles relative to the history of drainholes. These articles were most instructive and both Mr. J. B. Murdock, Jr., and Eastman Oil Well Survey should be complimented for their donation of historic information on the subject.

May it be brought to your attention and the attention of your readers, that the conclusion of the series ends the latter part of 1953, and since that time the Oilwell Drainhole Drilling Company has acquired from Eastman Oil the original Lee Patent.

Further, since the article was concluded in 1953, a greater number of drainholes have been drilled throughout the United States than the entire number referred to in these articles. Because of improvements in the tools and techniques, a great degree of success and acceptance has occurred that puts an entirely new light on the subject.

In lieu of the printed article being more concerned with statistics and details of the earlier history of drainholes, I understand *The Petroleum Engineer* anticipates preparing an article, containing information and results that will bring the reader currently up to date on this technique.

W. E. Sievers

Sievers Company
Long Beach, California

Editor's Note: The article mentioned in the last paragraph is in preparation and will be published in an early issue.

IDEA!

With all the history and records of oil and gas operations and progress that have been printed, it is still the personal accounts of struggle and failure and success that give the true picture of the oil industry.

The Oil Industry As I Saw It, the autobiography of W. L. Connelly, *The Great Wildcatter*, story of Mike Benedum, *Hugh Roy Cullen*, biography of the Houston independent — these are the books that thrill and inspire their readers. The story of H. L. Hunt is in preparation.

There are other men in the industry who have had wonderful experiences in this fascinating oil business. They also should look toward writing, or having some one else write, the exciting record of one man's life in the petroleum industry.

THE Petroleum Engineer — Management Edition

Exploration—Drilling—Producing • Refining—Petrochemicals—Gas Processing • Oil and Gas Pipelining

APRIL, 1955 • VOLUME XXVII • NUMBER 4

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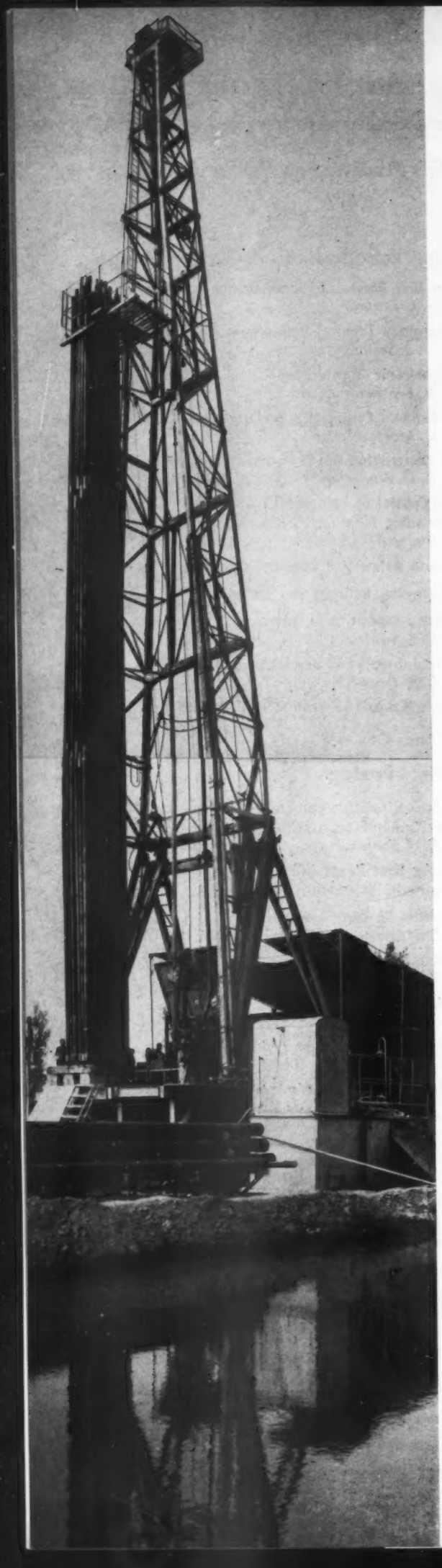


Drilling at Piadena, Italy — ENI Photo

What Does the Price of Oil Cover?

In Europe – which owes more to oil than to any other one industry for its economic recovery since World War II – there is presently dissatisfaction with the price of crude oil. A proposal to fix what is termed "right" prices is made by a UN report, which is inspiring newspaper headlines in Europe but seems to be restricted in the United States.

What should *the price of oil cover?*

The answer to that question is bigger than the oil industry. The answer involves freedom and slavery. If the price of oil is not to cover the billions spent every year on geological parties in Costa Rica and seismic crews in Somaliland – on the drilling operations in Cuba and in Sicily – on new refineries in the Philippines and in Aden – on new pipe lines in Canada and Sumatra – on new filling stations in Germany and Japan – If the price of oil does not cover these operations and facilities, then tax-supported governments must take over and/or we'll do with less and less oil until present reserves are depleted and the world grows dark again.

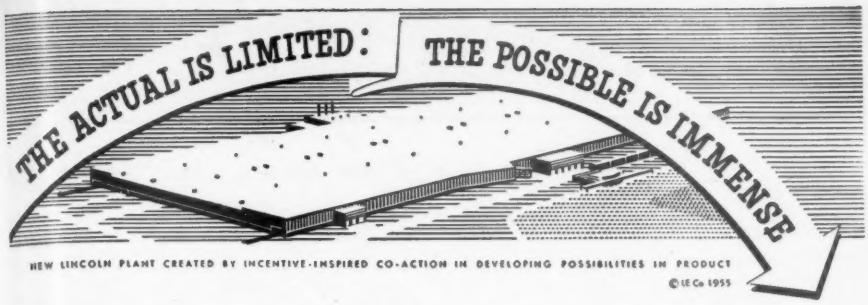
What should *the price of oil cover?*

Should it cover only the cost of producing a fabulous find like Kuwait? Then who shall pay for the fabulous failures? Who shall pay the billions in capital needed to find future supplies that may lie hidden in the Continental Shelf off U. S. shores or along the seacoast of Brunei – or in the deserts of Egypt or the hinderlands of Australia?

Of course it is the consumer who must pay if he and the international oil industry are to remain free. The price of oil must cover the expenses of the oil industry or be subsidized.

No one can place a "right" price on oil – it is priceless. It is lifting the human race from darkness and drudgery and hunger and immobility as its use increases in the four corners of the earth. When the industry is allowed freedom – freedom to work and to let the price of its work be set in the market place – the supply is always there and the price is always cheap.

Ernestine Adams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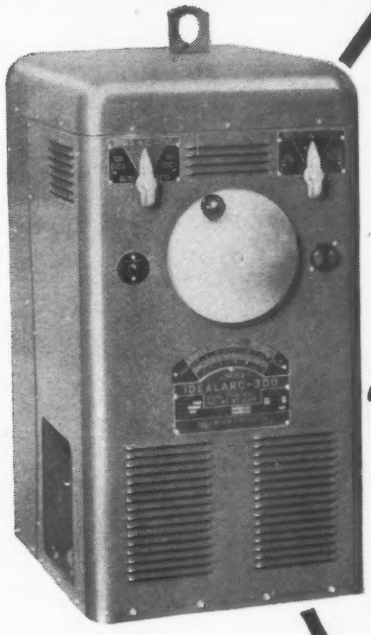

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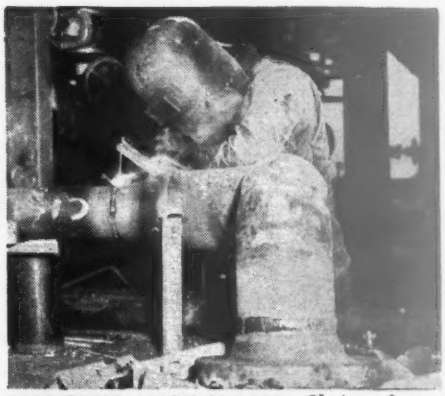

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HIGHLIGHTS ★ ★ ★

Digest of News and Comment

Oil stocks on hand continue to shrink, even though refinery runs remain high. Fuel demand, although aided by cold weather, rode along with high retail sales and automotive sales to establish a record nearly 10 per cent above last year's first quarter.

★ ★ ★

Federal highway programming hit two new snags concerning toll roads and methods of financing. The administration's vindication of toll roads has met with disapproval of the National Oil Jobbers Council on the grounds that licensing of concessionaires along toll roads would be a bar to free enterprise, and tend toward state monopolies. Oregon senators are suggesting a three cent gasoline tax, instead of present two cent levy, while others are calling for complete abolition of the levy. One scheme for raising the $20,000,000 through three per cent government bonds, has been labeled a giveaway.

★ ★ ★

Power, oil and gas receipts may eventually make the Interior Department self-sustaining, according to its secretary, Douglas McKay. The department has made a bid for a federal appropriation of $424,461,000 for the coming fiscal year. Outer shelf tidelands along Louisiana and Texas Gulf Coast will bring in a total of $6,000,000,000 in rentals, bonuses and royalties, McKay told the appropriations committee.

★ ★ ★

Texas Railroad Commission has trimmed almost 60,000 bbl daily from the state's production allowable for a daily run of 3,275,074 bbl through the month of April. Most Texas fields will be placed on a 17-day producing schedule.

★ ★ ★

Socony-Vacuum will assume the role of contractor in exploratory activity in Portugal, with a working interest on rights held by Companhia dos Petroleos de Portugal. This company is controlled largely by the Portuguese government and the Axel Johnson interests of Stockholm. Activities of the American company will be carried on under the recently organized Socony-Vacuum Exploration Company with headquarters in Lisbon.

★ ★ ★

Esso Standard, S.A.F. (Jersey Standard and Gulf) will establish a new organization to develop existing production and exploit new areas in France. The subsidiary will bear the name Societe Esso de Recherches et d'Exploitation Petroliere. It was recently announced that the American company's Esso No. 1, Parentis field, was completed with a daily potential of 3500 bbl per day.

★ ★ ★

American Republics Corporation-Sinclair Oil Corporation merger may not have been the largest in history, but it may have carried the most weight, literally. The transaction, concluded March 23, involved signing some 12,000 documents weighing an estimated three or four tons.

★ ★ ★

President Eisenhower cautioned observers that the cabinet committee report on fuels recently presented does not as yet have his blanket approval. Most provocative section suggested that the Federal Power Commission's authority to regulate the sale of natural gas by independent producers be removed. The President may await the outcome of pending congressional action, before taking a stand on the controversial issue.

★ ★ ★

North Dakota's April crude allowable has been set at 23,885 bbl per day, a decrease from last month's proration of 33,559. The April figure represents only about 8 bbl per day per well.

★ ★ ★

Oklahoma crude allowable for April has been cut back about 10,000 bbl per day by the state commission. In southern Oklahoma fields purchasers have been taking only 65 to 80 per cent of the allowed runs for the past few months. Although the March allowable set was 575,000 bbl, average run was 559,950 bbl.

Quoted on two occasions, Socony-Vacuum says it will cut back its crude imports, starting at 5000 bbl in May and gradually working downward to 16,000 bbl daily less than present level. The voluntary cut will be made effective through elimination of import increases scheduled to come from Canada to the company's Ferndale, Washington, refinery.

★ ★ ★

Gulf Oil Corporation produced more and more oil products—and earned more money doing it—than in any previous year. Net crude production averaged 763,200 bbl daily, with the company collecting some $1,705,328,795 from sales and operating revenue, and showing a net income of $182,813,045. On per share basis, Gulf netted $7.16 as compared with $6.86 per share in 1953.

★ ★ ★

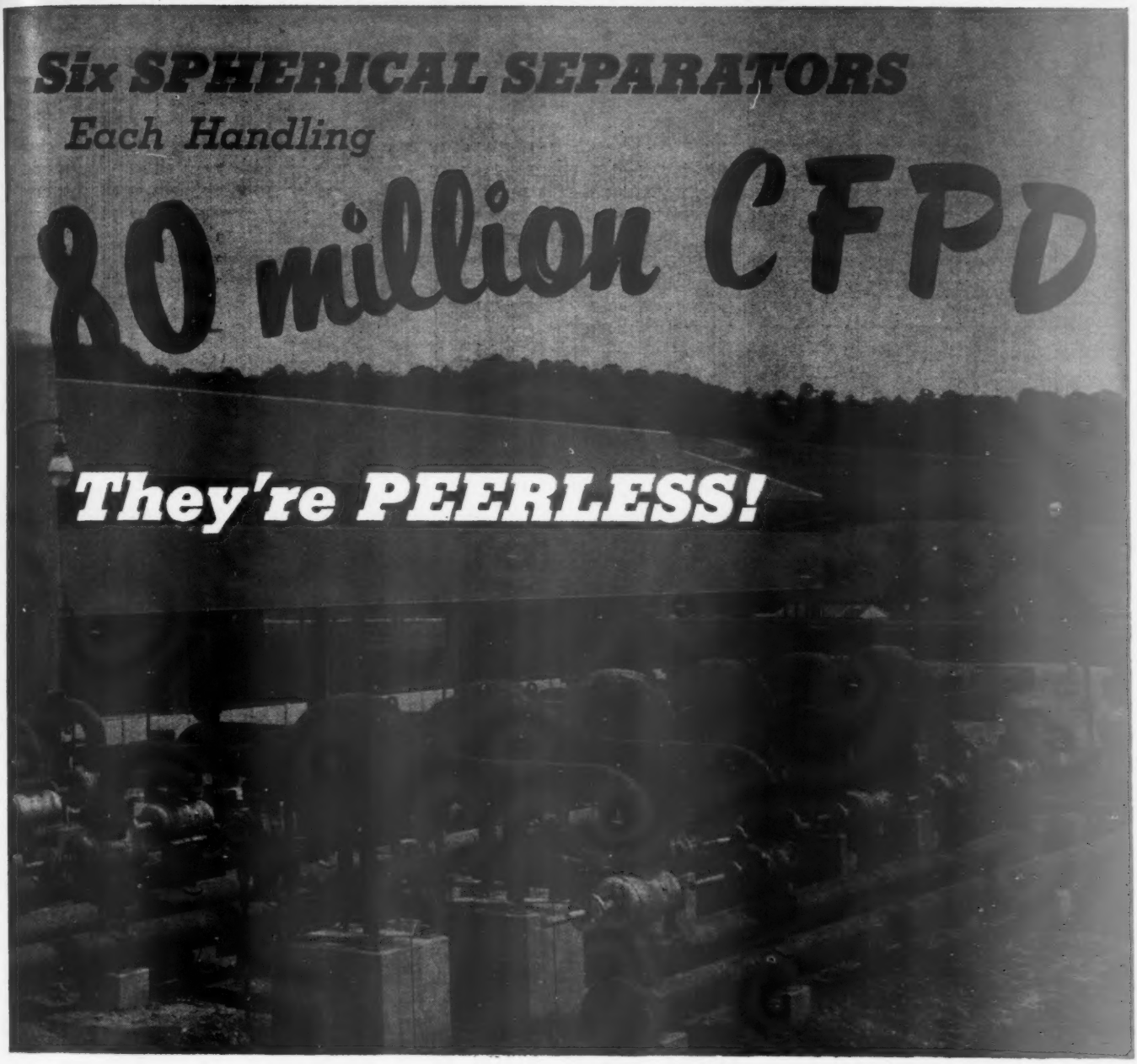
University of Oklahoma's school of petroleum engineering is inviting application for five graduate fellowships available next year. Offering stipends ranging from $1500 to $1600 are Humble, Stanolind, Sinclair, Shell, and Lane Wells. Applications must be made by April 15.

★ ★ ★

FPC admits that it wants no part in trying to regulate natural gas producers, according to testimony given by the power commission chairman Kuykendall before the House commerce committee. Among reasons given, Kuykendall cited that Supreme Court had singled out one mining operation for federal control, that artificially fixed prices could exhaust gas supply prematurely, and that public utility regulation has never been sufficient incentive for economy of operation.

★ ★ ★

Socony-Vacuum has raised wholesale gasoline prices as much as two cents per gallon to dealers in parts of Massachusetts, Rhode Island and Connecticut. Socony also raised dealer's prices in New Jersey one cent a gallon following similar boosts by Esso and Gulf. Retailers in this state have upped prices on all grades of gasoline as much as seven cents per gallon.



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REPRESENTATIVES IN ALL PRINCIPAL CITIES

Texas oil man Hugh Roy Cullen claims he has given away 93 per cent of his worldy goods. University of Houston has received $11,000,000 of the fortune, along with oil leases and royalties. Exaggerations about his gifts to the college, Cullen said, have given a false impression about the school's financial solidarity.

★ ★ ★

Federal court order has dimmed any hopes of six railroads to lower freight rates on petroleum products in the Pacific Northwest. An injunction has been in effect to stave off lower rate allowed by Interstate Commerce Commission order issued late in 1953. Rate would have rendered pipelines, barges, and trucking impractical.

★ ★ ★

Long-awaited release of the presidential report on fuels and resources has set legislative wheels grinding. Most of the report has met with approval in the oil industry, although the suggestions concerning imports failed to please many — too mild for independents, too pointed for the internationals.

★ ★ ★

"If you can't fight them — join them" attitude has been accepted by the Southern Pacific Company. The railroad, first to build a major pipeline, will lay oil products lines from Los Angeles to Phoenix and Phoenix to El Paso. Standard of California is already interested in use of the line.

★ ★ ★

Effect of fuel and resources report to Eisenhower concerning voluntary crude import restrictions has been a cut back by several of the majors. So far, Gulf, Jersey Standard and Standard of California have announced imports reductions. California Standard will trim its imports by 11,000 bbl per day, while Jersey Standard will bring in "a little less," and Gulf "will go along with the others."

★ ★ ★

For the last 11 years, liquid hydrocarbon reserves in the United States have been increased to reach a high of 34,804,000,000 bbl. This figure represents 29,560,000,000 bbl of proved crude reserves and 5,244,000,000 bbl of natural gas liquid. Although Texas and California, representing the largest oil stockpiles, registered decreases from 1953 totals, Oklahoma and Louisiana have shown substantial gain from new discoveries, field extensions and revisions.

★ ★ ★

Congressman Heselton of Massachusetts has assumed the lead in opposing exemption of natural gas producers from federal regulation on the grounds that: "The 25 million odd gas consumers whose rates were increased over the last five years by about $200,000,000 are interested in some protection assuring reasonable rates and fair profits." Heselton is presenting two bills in opposition to two others asking Congress to nullify Supreme Court ruling.

★ ★ ★

Saudi Arabian government has granted an American company, International Development Services, exclusive rights to petrochemical development from excess natural gas from oil production in Arabia. Government would share in profits equally.

★ ★ ★

State legislation to open up oil drilling on California-owned tidelands has been endorsed by State Finance Director John M. Peirce. The official estimated that California had more than 4 billion barrels of oil under submerged lands, which would yield the state $2.5 billion in revenue.

★ ★ ★

Wage increases averaging 10 cents per hour have been the trend this past month. Magnolia, Continental, Humble, Esso Standard, Standard of California, Atlantic and others have made increases. Although non-union and independents are accepting the raise, some larger unions are holding out for more.

★ ★ ★

Seven natural gas companies have returned $14,691,814 to wholesale companies under government advisement. Most of the amount is result of Supreme Court's invalidation of a Texas tax on gas gathering.

Jersey Standard has formed a company with Italian interests to be known as Augusta Ricerche Petrolifere, S. F. A., to drill for oil in Sicily. First exploratory well is scheduled around May 1 on one of three tracts totaling 215,000 acres.

★ ★ ★

Newly organized Oil, Chemical and Atomic Workers International (CIO) is hunting for 800,000 members from oil and chemical industries. Present strength is less than 200,000. Union was formed by merger of CIO's Oil Workers' International Union and the United Gas, Coke and Chemical Workers' Unions.

★ ★ ★

Although eleven companies have been approved to buy a portion of the five per cent oil consortium set aside for American independents in Iran — question of who gets how much must be settled. Each company has expressed a desire for one to five per cent, or all the allotted amount.

★ ★ ★

Oil companies involved in international trade are under fire by British newspapers as price fixers. Uproar began with United Nations report on "Price of Oil in Western Europe," claiming that Middle East oil prices are linked with those in the United States and suggesting that prices be fixed by governments.

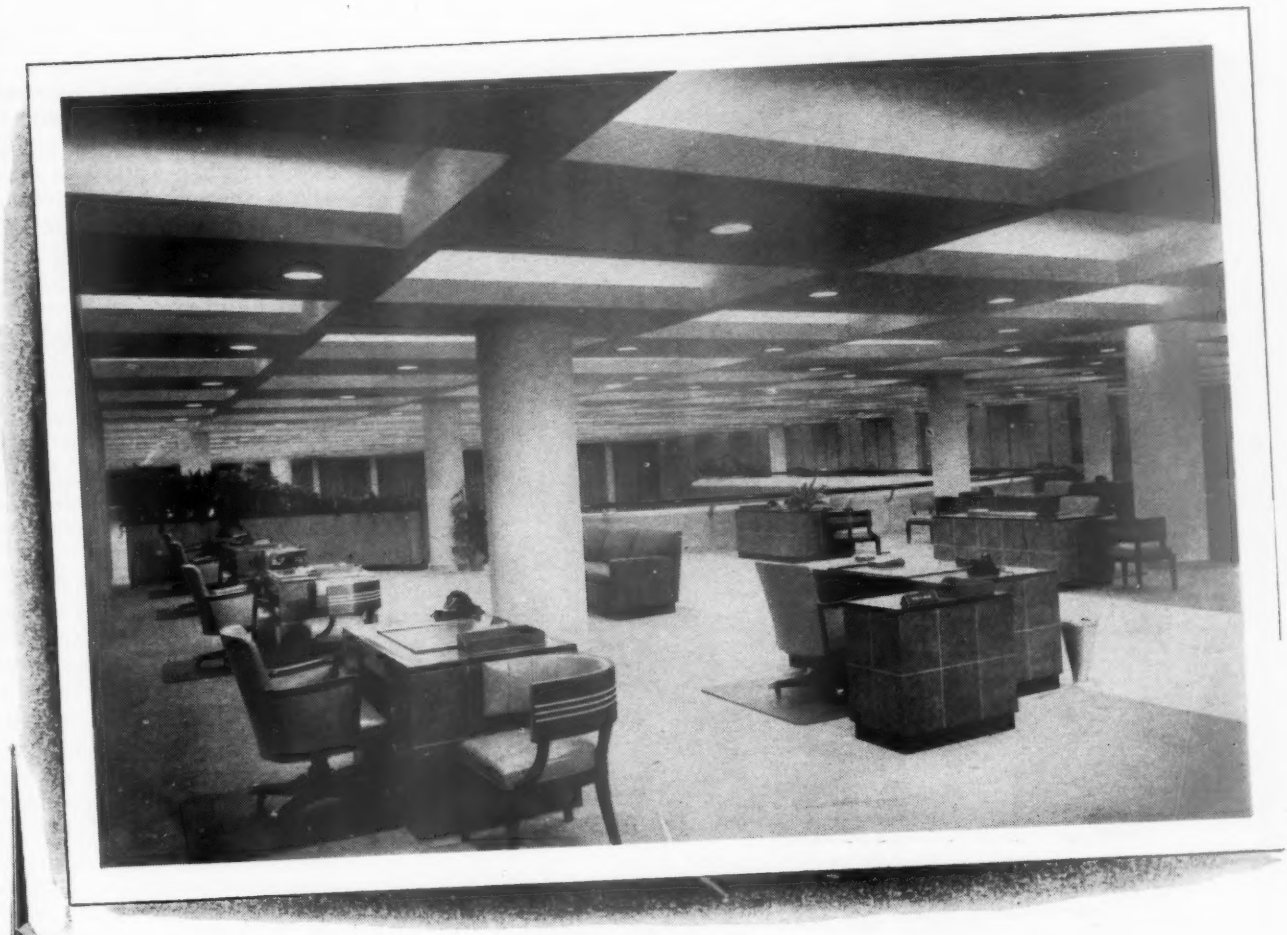
★ ★ ★

Although twenty-odd synthetic rubber plants were sold recently by the government without a hitch, the remaining three are calling for new legislation to reopen bidding. A bill introduced by Texas senators, which would attempt to dispose of Baytown, Texas, plant is meeting with stiff opposition. The one bid submitted was rejected as too low.

★ ★ ★

Intrastate trucking hearing has been reset by the Interstate Commerce Commission for June 13. Time will be allowed to "any interesting party" without reservation. It has been proposed that the agency assume jurisdiction over truckers hauling products from pipeline and marine terminals.

WHERE OIL WELLS BEGIN . . .



This is a picture of a part of the Oil Department at Republic. Behind long lines of doors to the right and left is a complete staff of experienced oil men, engineers and geologists.

Behind *them* is the financial strength and the oil "know-how" of one of the first banks to make Oil Production Loans. Production loans originated here have helped add billions of barrels to the nation's oil and gas reserves — and have made the Republic "*The* Oil Bank" to oil men all over America.

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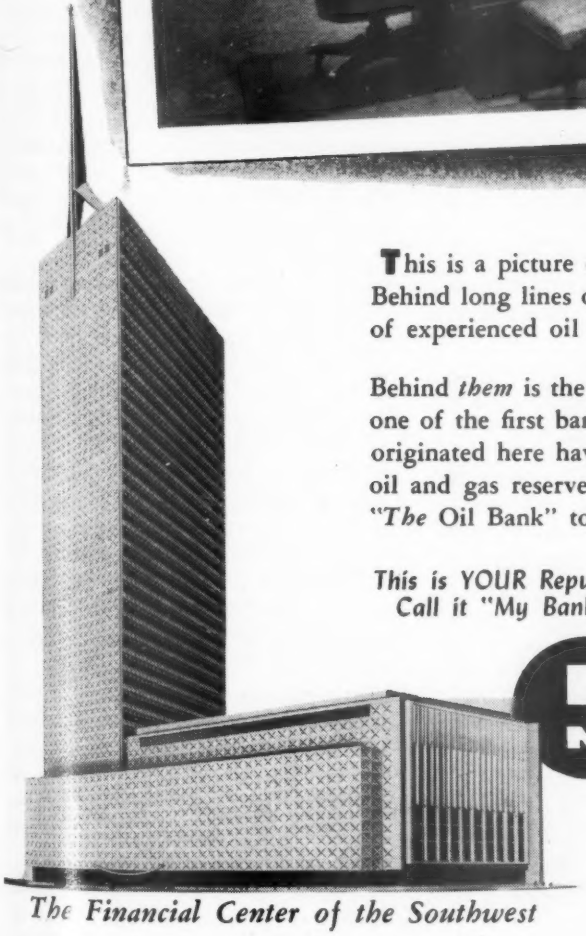

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Petroleum Profile

Jack A. Crichton
Oil Man

At the age when most young men are getting started in the climb to success, 38-year-old Jack Crichton of Dallas, Texas, is near the top. He is president and director of Oil and Gas Property Management, Inc., and of Empire Oil and Gas Management, Inc., Dallas and New York, and vice president of Empire Trust Company, New York.

If ever a man were destined for a career in oil, it was Jack Alston Crichton. He was born on a large plantation in Crichton, Louisiana, which had been in his family since 1870. It was producing oil before he was born.

From infancy he hob-nobbed with successful oil men, and his early inclination toward the profession had the backing of family and friends. One of these, N. C. McGowen, president of United Gas Corporation, United Gas Pipe Line Company, and Union Producing, encouraged young Crichton to enroll in Texas A&M College and study petroleum engineering.

Jack arrived at the military school in the fall of 1933. He was 16 years old, a little over five feet tall, and weighed 110 pounds. "They tell me," he recalls, "that there was one man in the freshman class smaller than I was. I don't remember him."

Encouraged by the entire sophomore class who assured him that he had a great future as an athlete, Jack went out for wrestling. In the first few seconds of his initial bout his opponent tossed him out of the ring and broke his collar bone. Jack has no doubt now that this was a move on the part of the sophomores to rid their beloved school of the scrawny freshman from Louisiana.

But Jack doesn't give up easily. He switched his athletic enthusiasm to basketball, cross country, and tennis, stayed around to play on the varsity in all three sports and gain himself the nickname of "Teal" from the swift and tricky teal duck — and rack up a shelfful of tennis trophies. He also earned a wide assortment of scholastic and military honors.

In the fall of 1937, with a degree in petroleum engineering, Jack entered Massachusetts Institute of Technology. One year later he took his master's degree in the same subject with a minor in geology. During his pre-graduate days, Jack had worked as a swamper with a Shreveport, Louisiana, drilling contractor. When he finished MIT, he joined Union Producing as a geologist.

From 1941 to 1946 Jack Crichton took a four-year leave-of-absence from the oil business to help fight the war. In 1946 he joined DeGolyer and MacNaughton as a petroleum geologist and engineer. He was elected a vice president and director of the firm in 1950 and one year later resigned to help organize the San Juan Oil Company, of which he was vice president and a director.

His present position as president and director of Oil and Gas Property Management makes him a BIG oil operator. His company has interests in 1070 wells, producing 6500 bbl of oil and 80,000,000 cu ft of gas daily. The company headquarters in Dallas, maintains offices in Houston and Amarillo, employs some 160 people. Empire Oil and Gas Management, of which he is also president and a director, is a management and consulting firm that manages properties for other owners, advises concerning engineering and geological matters and the acquisition of oil and gas properties.

Jack Crichton is a member of the American Institute of Mining and Metallurgical Engineers, American Association of Petroleum Geologists, Texas Society of Professional Engineers, Dallas Geological Society, Dallas Petroleum Engineers Club, Dallas Geophysical Society, and the Engineers Club of Dallas. He has at some time during the past five years, been an officer in most of these organizations. He is a member of Tau Beta Pi, Sigma Alpha Epsilon, and the River Club of New York, and was awarded a professional degree from Texas A&M.

Petroleum engineering takes a back seat when Jack goes home to 7019 Pasadena in Dallas. There his two girls, Marilyn Berry Crichton, whom he married in 1952, and their year-and-a-half-old Anne Alston are the real queens of his universe.

It would seem that he has just about climbed to the top of the ladder of success, but if there are any higher rungs, you can count on Jack Crichton to find them — and conquer them.

Meetings

April 4-5—**Oil Recovery Conference,** Texas Petroleum Research committee symposium on the Wilcox Trend of Texas, Memorial Student Center, Texas A&M College, College Station, Texas.

April 4-8—**American Petroleum Institute,** safety and fire protection committees, mid-year meeting, Jung Hotel, New Orleans, Louisiana.

April 5-7—**Corrosion Control, Short Course,** University of Oklahoma Section, National Association of Corrosion Engineers, University of Oklahoma Extension Study Center, Norman, Oklahoma.

April 12-15—**American Petroleum Institute,** division of production, Rocky Mountain district meeting, Gladstone Hotel, Casper, Wyoming.

April 13-15—**Natural Gasoline Association of America,** annual, Baker and Adolphus Hotels, Dallas, Texas.

April 13-15—**National Petroleum Association,** semiannual, Cleveland, Ohio.

April 13-15—**American Society of Lubrication Engineers,** annual, Hotel Sherman, Chicago, Illinois.

April 18-20—**American Society of Mechanical Engineers,** spring meeting, Lord Baltimore Hotel, Baltimore, Maryland.

April 19-21—**Southwestern Gas Measurement Short Course,** University of Oklahoma, Norman, Oklahoma.

April 19-20—**Pacific Coast Gas Association,** distribution conference, Phoenix, Arizona.

April 20—**American Society for Testing Materials,** regional, Broadview Hotel, Wichita Falls, Texas.

April 20-22—**Petroleum Industry Electrical Association,** annual, Shamrock Hotel, Houston, Texas.

April 20-22—**Petroleum Equipment Suppliers Association,** Shamrock Hotel, Houston, Texas.

April 24-27—**American Society of Mechanical Engineers,** Region VIII engineering conference, Rice Hotel, Houston, Texas.

April 25-26—**Independent Petroleum Association of America,** midyear meeting, San Antonio, Texas.

April 28-29—**American Petroleum Institute,** division of production, Statler Hotel, Los Angeles, California.

April 29-30—**American Association of Petroleum Landmen,** Hilton Hotel, Fort Worth, Texas.

May 1-4—**American Institute of Chemical Engineers,** annual, Shamrock Hotel, Houston, Texas.

NOMADS TO MEET

New York, N. Y., Chapter, First Monday of the Month, Biltmore Hotel, New York. Secretary, O. B. Latrobe.

Houston Chapter, Second Monday of the Month, Ye Olde College Inn, Houston, Texas. Secretary, Harry E. Estes.

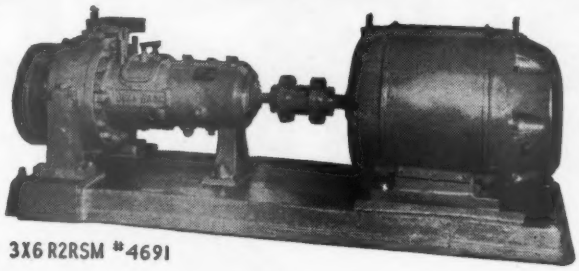
Los Angeles Chapter, Second Wednesday of the Month, Jonathan Club, Los Angeles, Calif. Executive Secretary, Wallace A. Sawdon.

Tulsa Chapter, Third Friday, "After Five," Room, Hotel Tulsa. Secretary, Gilbert Swift.

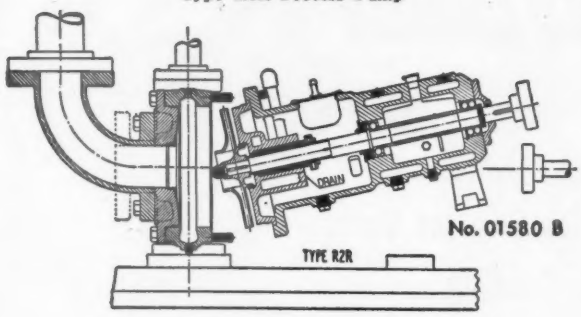
Dallas-Fort Worth Chapter, Dallas, Texas. First or Second Monday of the Month. Secretary, Glen Tableman.

DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



Type R2R Process Pump



Type R2R Process Pump

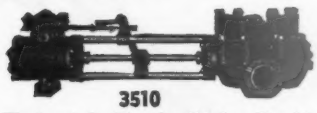
DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

OPERATING RANGE: Type R2R, Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
Capacities: 50 to 2000 Gallons per minute. Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

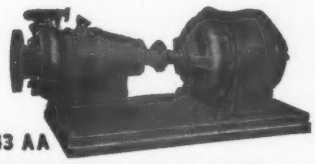
BUILDERS OF OUTSTANDING PUMPS SINCE 1869

CENTRIFUGAL AND RECIPROCATING PUMPS

Close Coupled Centrifugal Pump

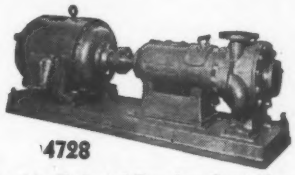


3510
Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids

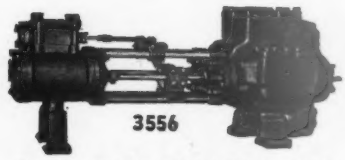


4043 AA
Pedestal Mounted Centrifugal Pump

3833
Horizontal, Duplex, Double Acting Side Pot, Piston Type, Oil Bath Power Pump



4728
Double Pedestal Bearing Centrifugal Pump



3556
Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

ESTABLISHED 1869

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with SPEED CHUCK

Light Weight...
Easily Quickly Set Up...
Built-In Folding Tool Tray and Folding Legs

Power for any hand pipe tools — ⅛″ to 2″ pipe, ¼″ to 2″ bolts; geared tools to 12″.

Pats. Applied For

Leg Spacing and Tool Tray assure solid rigidity, greater strength . . . No front leg to obstruct swing of die stock handles.

Fast Easy Chucking, new principle—guaranteed to grip tight both forward and reverse, won't slip, even with geared tools . . . 3-jaw centering device turns with pipe . . . Extra-powerful motor, larger brushes, longer commutator.

Your Supply House has it—
ready to demonstrate and expedite your order.

THE RIDGE TOOL COMPANY • ELYRIA, OHIO, U. S. A.

RIDGID
Work-Saver Pipe Tools

May 1-4—**Liquefied Petroleum Gas Association,** annual, Conrad Hilton Hotel, Chicago, Illinois.

May 2-4—**American Geophysical Union,** annual, Washington, D. C.

May 9-10—**American Gas Association,** gas supply, transmission and storage conference, Hotel William Penn, Pittsburgh, Pennsylvania.

May 9-12—**American Petroleum Institute,** midyear meeting, division of refining, Jefferson Hotel, St. Louis, Missouri.

May 11-12—**Pacific Coast Gas Association,** gas supply, transmission, and technical conference, Palm Springs, California.

May 11-13—**American Petroleum Institute,** division of production, Eastern district Spring meeting, William Penn Hotel, Pittsburgh, Pennsylvania.

May 12-13—**"Automotion**—Engineering for Tomorrow," School of Engineering Symposium, annual, Michigan State College, East Lansing, Michigan.

May 12-19—**Latin American Congress of Chemistry,** annual, Caracas, Venezuela.

May 15-18—**Products Pipe Line Conference,** annual, Edgewater Beach Hotel, Chicago, Illinois.

May 16-18—**American Petroleum Institute,** division of transportation, midyear committee conference, Edgewater Beach Hotel, Chicago, Illinois.

May 16-18—**Southern Gas Association,** annual, New Orleans, Louisiana.

May 17-19—**Pennsylvania Gas Association,** Ponoca Manor Inn, Ponoca Manor, Pennsylvania.

May 26-27—**Western Petroleum Refiners Association,** regional technical-industrial conference, Settles Hotel, Big Spring, Texas.

May 26-27—**Kentucky Oil and Gas Association,** annual, Lafayette Hotel, Lexington, Kentucky.

May 30-June 1—**Chemical Institute of Canada,** 38th annual conference and exhibit, Quebec City, Quebec, Canada.

May 31-June 3—**Design Engineers,** annual exposition and technical conference, Convention Hall, Philadelphia, Pennsylvania.

June 1-3—**Short Course in Gas Technology,** Texas College of Arts and Industries, Kingsville, Texas.

June 3-5—**Desk and Derrick Seminar,** sponsored by Dallas Club for Regions 4 and 5, Southern Methodist University, Dallas, Texas.

June 5-9—**Canadian Gas Association,** annual, Seraton-Brock Hotel, Niagara Falls, Ontario, Canada.

June 6-10—**American Petroleum Institute,** division of production, midyear committee conference, Brown Palace Hotel, Denver, Colorado.

June 6-15—**Fourth World Petroleum Congress,** Rome, Italy.

June 9-10—**Pennsylvania Grade Crude Oil Association,** Hotel William Penn, Pittsburgh, Pennsylvania.

June 9-10—**Natural Gas and Petroleum Association of Canada,** Royal Connaught Hotel, Hamilton, Ontario, Canada.

June 11-15—**Petroleum Equipment Suppliers Association,** annual, Banff Springs Hotel, Banff, Alberta, Canada.

June 12-17—**SAE Golden Anniversary** summer meeting, Chalfonte Hadden Hall, Atlantic City, New Jersey.

June 16-18—**Interstate Oil Compact Commission,** Cosmopolitan Hotel, Denver, Colorado.

June 20-23—**American Society of Mechanical Engineers,** semiannual meeting, Statler Hotel, Boston, Massachusetts.

June 23-24—**Western Petroleum Refiners Association,** industrial relations meeting, Broadview Hotel, Wichita, Kansas.

June 26-July 1—**American Society for Testing Materials,** committee on D-2, petroleum products and lubricants, Chalfonte Hadden Hall, Atlantic City, New Jersey.

August 15-17—**Society of Automotive Engineers,** West Coast meeting, Hotel Multnomah, Portland, Oregon.

September 2-3—**American Association of Desk and Derrick Clubs of North America,** annual, New York, New York.

September 11-13—**Independent Natural Gas Association,** Jasper Park Lodge, Jasper National Park, Alberta, Canada.

Sept. 12-16—**Instrument Society of America,** national instrument conference and exhibit, Los Angeles, California.

Sept. 14-16—**National Petroleum Association,** annual, Traymore Hotel, Atlantic City, New Jersey.

Sept. 22-23—**Mid-Continent Oil and Gas Association,** Louisiana-Arkansas division, annual, Roosevelt Hotel, New Orleans, Louisiana.

Sept. 22-23—**Western Petroleum Refiners Association,** regional technical-industrial meeting, Henning Hotel, Casper, Wyoming.

Sept. 25-28—**American Association of Oilwell Drilling Contractors,** annual, Rice Hotel, Houston, Texas.

Sept. 25-28—**American Institute of Chemical Engineers,** Lake Placid Club, Lake Placid, New York.

Oct. 2-5—**American Institute of Mining and Metallurgical Engineers,** petroleum branch fall meeting, Roosevelt Hotel, New Orleans, Louisiana.

Oct. 2-7—**American Society for Testing Materials,** Committee D-2, petroleum products and lubricants, Statler Hotel, Washington, D. C.

Oct. 3-7—**American Institute of Electrical Engineers,** fall meeting, Morrison Hotel, Chicago, Illinois.

Oct. 13-14—**California Natural Gasoline Association,** annual fall meeting, Ambassador Hotel, Los Angeles, California.

Oct. 17-19—**American Gas Association,** annual, Los Angeles, California.

Oct. 20-21—**Western Petroleum Refiners Association,** regional technical, industrial relations meeting, Garrett Hotel, El Dorado, Arkansas.

Oct. 31-Nov. 2—**National Lubricating Grease Institute,** annual, Edgewater Beach Hotel, Chicago, Illinois.

Nov. 13-18—**American Society of Mechanical Engineers,** 75th anniversary meeting, Hilton and Blackstone hotels, Chicago, Illinois.

Nov. 14-17—**American Petroleum Institute,** annual, San Francisco, California.

Nov. 27-30—**American Institute of Chemical Engineers,** annual, Statler Hotel, Detroit, Michigan.

Feb. 19-23—**American Institute of Mining and Metallurgical Engineers,** annual Statler Hotel, New York, New York.

1956

Feb. 26-29, 1956—**American Institute of Chemical Engineers,** Statler Hotel, Los Angeles, California.

Sept. 10-14—**Instrument Society of America,** annual conference and exhibit, Detroit, Michigan.

Oct. 14-17—**American Institute of Mining and Metallurgical Engineers,** petroleum branch, Biltmore Hotel, Los Angeles, Calif.

internal swivel action gives you two-way control over movement of piping

With the Blaw-Knox functional spring hanger, you can readily control both lateral and longitudinal swing movements of hanger rod up to 7 degrees.

For the hanger is designed with the Blaw-Knox patented *internal swivel action*, which permits movement while the hanger case itself remains vertical. Larger movements are readily accommodated by overhead roller assemblies. Each is a complete packaged unit ready to install.

In fact, our entire line of rigid hanger assemblies, overhead roller assemblies, vibration eliminators, as well as the functional spring hangers and constant support spring hangers are furnished as complete units . . . thereby saving engineering time and eliminating expensive cutting, threading and assembling in the field.

Our engineers, who have had years of experience, are available to both design and make recommendations for your hanger requirements.

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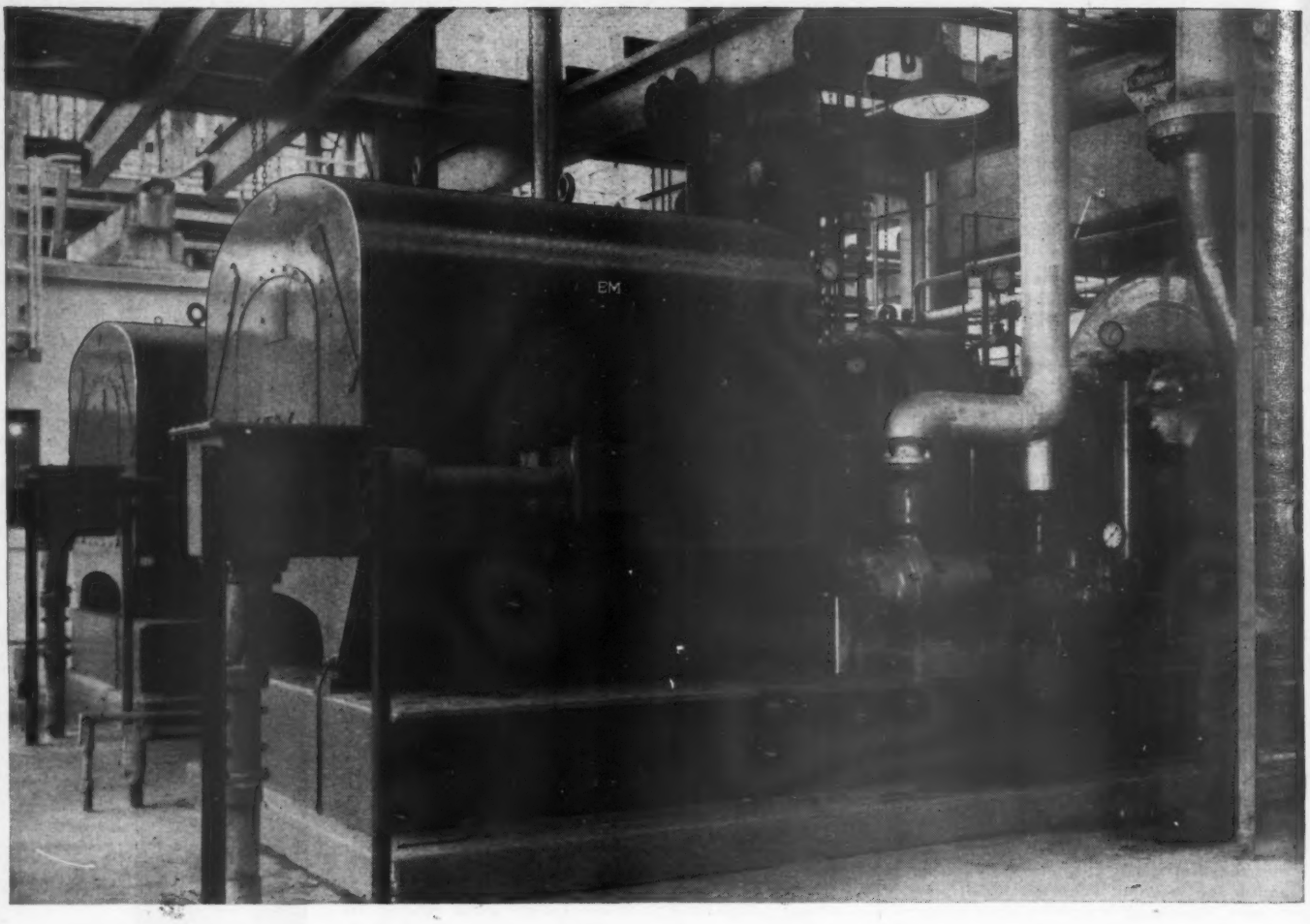
BLAW-KNOX **PIPE HANGERS**

Complete line of functional spring hangers • constant support spring hangers • rigid hanger assemblies • overhead roller assemblies • supports • vibration eliminators . . . plus complete prefabricated piping systems for all pressures and temperatures



Compressor drives . . . outdoor style!

● Right outdoors in Canadian weather are these two E-M Weather-Protected Induction Motors at the Vancouver, B. C. refinery of Imperial Oil Co., Ltd.

Rated at 1500 hp, 1750 rpm, the Motors drive centrifugal compressors and are among the largest such drive units built to date for outdoor installation without total enclosure.

This installation demonstrates two important advantages of E-M outdoor drives:

FIRST, E-M Weather-Protected Motors do not require expensive indoor floor space.

SECOND, their weather-protected construction allows them to be installed outdoors, away from explosive atmospheres.

E-M Weather-Protected Induction Motors have many other advantages as well. No special foundations are necessary. The protective hood sheds falling or blowing precipitation. Screened air intakes located above the motor feet prevent the entrance of refuse. And because ventilating air enters at low velocity, suspended particles are dropped before they reach vital motor parts.

Special "blow-through" passages provide a by-pass for high velocity gusts of wind. Protective coatings guard the motor interior and exterior from weather hazards. Even with this extensive protection, access is quick and simple without dismantling the motor.

Find out how these E-M Weather-Protected Motors, located outdoors, can cut installation costs and reduce danger on pump or compressor drives. Call your nearest E-M Sales Engineer for full information. Write the factory for E-M Synchronizer No. 40, the special oil industry issue, showing Weather-Protected Motor installations.

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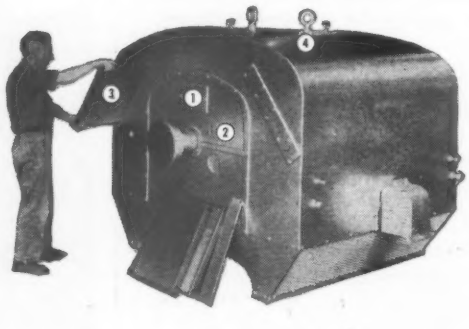
MINNEAPOLIS 13, MINNESOTA

PROTECTION WITH ACCESSIBILITY!

1. Door plates unlock quickly for handy access to bearing filler cap and oil ring inspection hole.
2. Large end plates permit bearing inspection, air-gap measurement, or blow-out of interior.
3. Intake air filters are easily removed for inspection or replacement.
4. Entire "weatherized" steel hood lifts by eyes for "all over" cleaning.



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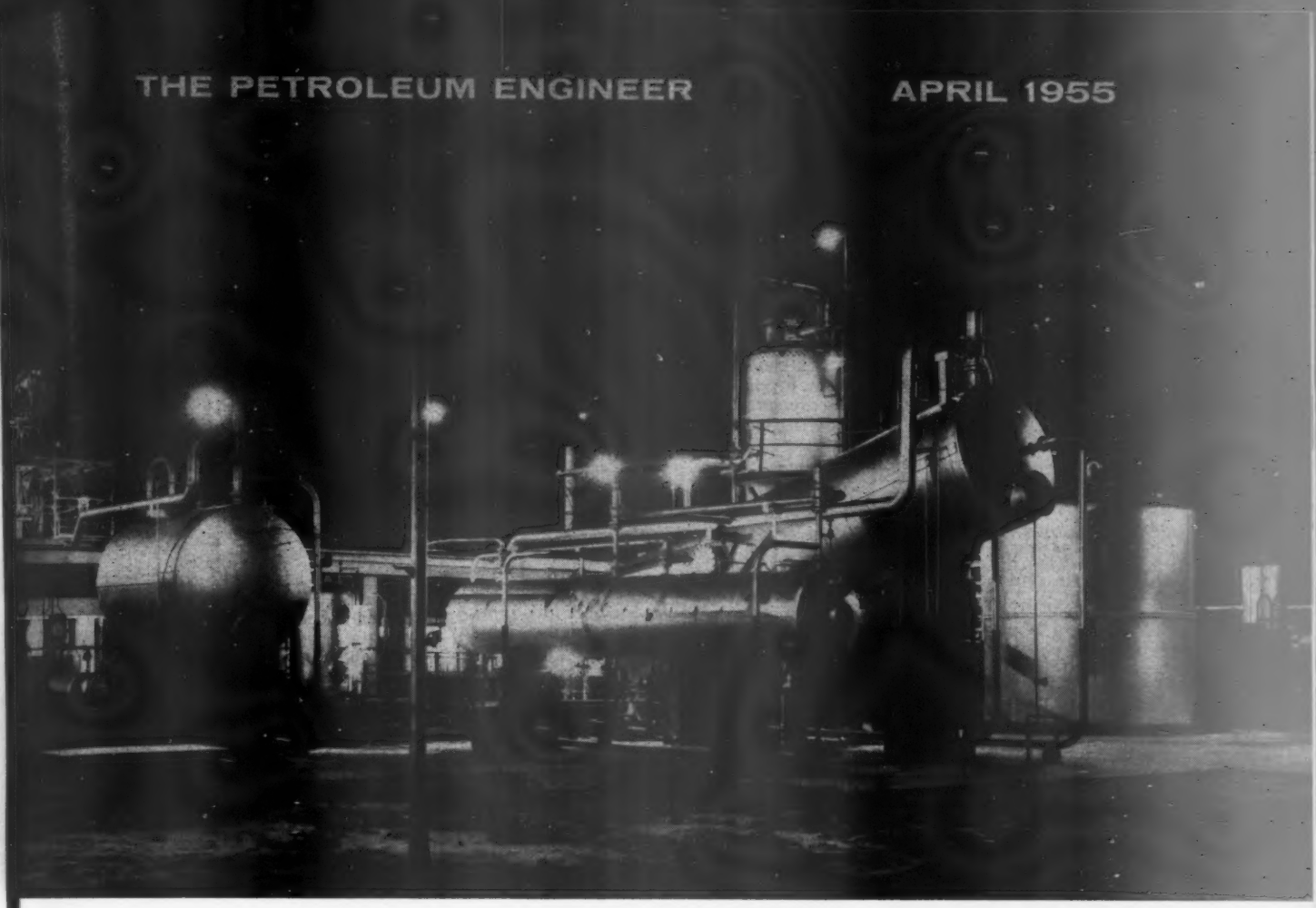
E-M

Specialists in making motors do exactly what you want them to



Treating plant by night of Caltex refinery at Bec d' Ambes, France.

P 100.

8th Annual Round-Up of World Oil Activities

Foreign Demand Rises Sharply in 1954

Ernestine Adams*

THE Finnish tanker Aruba, loaded with 13,000 tons of jet fighter fuel, bound for Red China held the eyes of the world for a time in March. Nationalist China threatened to seize or sink the tanker, which was leased to a Communist agency. Finally the crew refused to run the blockade.

It was only an incident but an intense, bitter one. It pointed up a fact too often taken for granted: Oil resources of the free world rank with the A and H bombs as a deterrent to aggressors. Red China can fight without these super weapons but it cannot fight without desperately needed petroleum supplies.

*Management Editor.

The free oil industry in 1954 pushed ahead with the confidence of long and successful experience. In more than a hundred countries or territories, operations went forward to seek and develop new supplies and to construct facilities to refine and transport them.

Demand outside the United States was still experiencing a healthy surge of expansion. While the U.S. was increasing demand by about one per cent, other nations of the free world were eagerly seeking increased supplies —an estimated overall rise of about 10 per cent. Free Austria ran 18 per cent above 1953; Brazil's requirements were up 15 per cent; Egyptian demand was 10 per cent ahead of 1953; Japan had a 16 cent rise; The Netherlands' consumption in 1954 was up 13 per cent over 1953; Peru's consumption went up 16 per cent and Pakistan had a 17 per cent increase in 1953 over 1952; Turkey had an 11 per cent rise in 1954; French consumption went up 12 per cent and even India, almost at the bottom of the list, had an increase of 5 per cent in demand over 1953.

There is no way of knowing about the changes in demand in Communist countries. Reports from the USSR state that production in 1954 was 10 per cent above 1953. About 9 per cent of the supply is being bartered in many parts of the world. Oil is Russia's most important export and consumption in

the Soviet can be turned on and off—increased or decreased to fit political policy.

Rise in demand in the free world, however, is a top factor in world progress. It means there are more asphalt highways, more oil lamps, more thirsty cars and tractors, more ships and planes. It is a certain indication of growing economic prosperity.

It means that in Britain, France, Germany, and Italy the number of cars bought each year was twice as large in 1954 as in 1950. It means that streamlined filling stations are springing up in quaint towns of western Europe to supply motorists.

It means new houses going up that are heated with fuel oil and more people traveling on diesel-powered ships and trains.

It means there's a boom on worldwise that is stronger outside the United States right now than it is within this country. Everyone — from Aden to Zanzibar — is trying to catch up with the living standards of the U. S. There is no better indication that some progress is being made than the bigger increase in oil consumption in free nations outside the U. S.

Oil operations have lent impetus to improved finances and better living conditions. Counting the lift to economic conditions powered by new oil resources — such as those found in 1954 in Italy, Cuba, and France — and the steady feeding of capital investment to all oil operations, you might say oil operations are the world's most significant economic factor.

U. S. oil companies maintain their lead in operations outside their country. Nearly 30 per cent of all U. S. foreign investments are in oil leases and facilities. This is estimated at $4 billion in capital funds. Importance of this in foreign countries is not only that it develops resources and upgrades imports (as in refining) and supplies cheap energy but also that the investment requires large local expenditures to operate and provides jobs for some 250,000 employees.

And wherever oil operators go, with them go examples of higher living standards, business efficiency, technological advances, and modern equipment.

Within the world oil industry an outstanding trend was the increase in number of firms operating in more than one country. The decision to bring 11 smaller oil companies into the Consortium handling Iranian oil was one indication of this. Hundreds of companies got their first taste of oil operations outside the U. S. in Canada and for some the experience was preliminary to extending interests to other countries with oil potential.

ADEN

R. C. 100,000 b/d

British Petroleum Company's new Aden refinery came into operation in August, four months ahead of schedule. With a capacity of 100,000 b/d, it has the world's first electronic control equipment for crude oil distillation units, and the first UOP Platformer (12,000 b/d capacity) to be commissioned in the Middle East.

AFGHANISTAN

Afghan government is reported to have employed Swedish drilling firm to explore sedimentary area in northern part bordering USSR.

ALASKA

Eight major oil companies were active in Alaskan exploration in 1954: Humble, Phillips, Ohio Oil, Richfield, Shell, Standard of California, Texas Company, and Union of California. They, with some smaller companies, spent about $4 million in 1954.

Phillips and Kerr-McGee Oil Industries, Inc., commenced drilling operations on a block of approximately one million acres in the Katalla-Yakataga area in southern Alaska. One well was abandoned at a depth of 4837 ft and a second well was drilling below 7390 ft at the end of the year. Surface geological studies were conducted during the summer months using helicopters for transportation from the camps to the field.

Iniskin Unit Operators (Havenstrite) began drilling in the Chinitna Bay area of the Alaska Peninsula August 4, 1954, and are down 6000 ft.

Alaska Oil and Gas Development Company (local) is drilling in the Nelchina Valley. Anchorage Oil and Gas is drilling for gas in the same province.

Demand in the U.S. territory runs about 7000 b/d.

ALBANIA

Prod. 4500 b/d (?) R. C. 3500 b/d (?)

Communist Albania has agreed to supply Italy with 185,000 bbl of crude oil in 1955.

ALGERIA

Prod. 1750 b/d

Only production from Oued Gueterini field, with 49 wells producing and estimated 3,000,000 bbl reserves. The 16 rigs in North Algeria and Sahara drilled 69 wells in 1954, of which 31 were producers. Nineteen geological crews and 15 geophysical crews are operating in the North African country. Algeria is open to foreign operators.

FOA Insures Two Italian Oil Investments

Two largest grants made by the Foreign Operations Administration went to oil companies. The largest guarantee was for $14,487,500 to Standard Oil Company (New Jersey) for capital investment in Italy.

Second largest project to be insured by the Government agency was investments by Socony-Vacuum Oil Company in an Italian subsidiary. The total amounted to $8,400,000.

FOA issues guaranties on funds invested abroad by American firms. The idea is to encourage U. S. business to put money into overseas operations. The program is limited to new investment.

ANGOLA

Petrofina put in 44 geological party months in Angola during 1954, 24 seismic party months and 5 gravity party months.

Exploration was in the Cuanza Basin where three wells were drilled at Cacoba, all having oil shows, and one test at Benfica. Another location was made near the last test, which went to 7057 ft.

ARGENTINA

Prod. 78,000 b/d R. C. 195,000 b/d

Yacimientos Petroliferos Fiscales, the state oil monopoly, is having a hard time trying to meet Argentina demands. Some 120,000 bbl of crude and products must be imported daily. Of the 78,000 b/d oil production, however, 62,000 b/d are YPF output. Of the remainder 4100 b/d are Shell's Comodora Rivadavio field.

YPF drilled 280 wells in 1953 of which 72 are dry and indications are that 1954 saw more drilling. About 50 rigs are in operation in Argentina.

Efforts to develop specific territories or to handle overall development of Argentina oil and gas resources have been made by Atlas, which proposes developing Neuguen oil fields and installing a 370-mile pipe line system from this area to the port of Bahia Blanca. Other proposals have been made by Shell, Jersey Standard, Caltex and other firms.

Shell added a 500 b/d (output) luboil unit to its Buenos Aires refinery (18,000 b/d crude intake).

Jersey Standard is adding a lubricants unit with 1000 b/d capacity to its Campana refinery. YPF's expansion at the Peron refinery is being completed by Kellogg.

ARUBA, N. W. I.

R. C. 475,000 b/d

Shell's refinery (35,000 b/d capacity) has been shut down since 1953. Lago (Jersey Standard) has a throughput of about 400,000 b/d.

AUSTRALIA

R. C. 45,000 b/d

Australia's first well to produce oil in some quantity, West Australia Petroleum's (50 per cent Gulf) Rough Range No. 1, was drilling at 13,599 ft at the end of 1954. Four others on the same lease were abandoned and another was drilling at 3241 ft. The same company was drilling on two other locations.

Associated Australian Oilfield's Roma No. 4 in Queensland had proved gas production of more than 870 mcf and was shut in. Roma No. 5 was drilling. Five other companies were drilling at the end of the year, making a total of 5 completed wells and 10 drilling.

Australia has had extensive exploration in 1954 and more is planned for 1955.

Refining capacity is being expanded steadily. Shell's refinery at Geelong, Victoria, completed at 25,000 b/d is being increased to 40,000 b/d by adding skimming and cracking units.

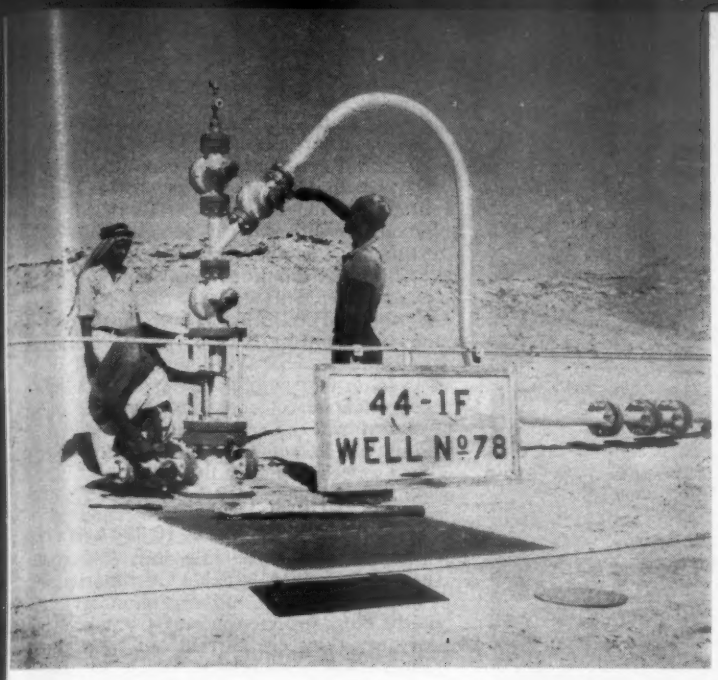
Standard-Vacuum has begun operating 2000 b/d at Altona, Victoria. When completed the plant will have 25,000 b/d capacity.

Construction is in progress at Australian Oil Refining, Ltd. 22,000 b/d plant at Kurnell; at Australasian Petroleum Refinery, Ltd. 70,000 b/d plant at Kwinana, and at British Petroleum 60,000 b/d refinery at Fremantle. The British Petroleum plant went on stream February 1, 1955.

AUSTRIA

Prod. 65,000 b/d (?) R. C. 40,000 bd (?)

Some 675 wells in Austria are estimated to average nearly 100 b/d each,



Well service crew check well on Bahrain Island.

Caltex photo

only a third of which goes into the Austrian economy; the remainder is exported by the Soviets to the Soviet bloc. Allocations for 1955 of petroleum products to Austrian economy by the Soviet Mineral Oil Administration are (in metric tons): Gasoline, 175,000; special and test gasoline, 8500; kerosine, 22,500; diesel oil, 202,500; fuel oil, 675,000; lube oil, 52,000; asphalt, 41,000.

Consumption runs about 25,000 b/d, almost 18 per cent above 1953.

Total capacity of 5 Soviet and 2 private refineries is estimated at about 40,000 b/d of which perhaps 30,000 b/d is utilized. Unused capacity is in the privately owned plants, dependent upon Soviet crude oil allocation. About 1400 b/d products are imported.

Estimates of reserves run from 150 to 250 million barrels of crude oil and about one billion cubic feet of gas. Some 160 miles of crude oil lines and 435 miles of natural gas pipe lines are laid in Austria.

All figures are estimates since the Soviet, which controls the industry, publishes none.

BAHAMAS

Only companies to renew their licenses during 1954 were Bahamas Exploration Company, Ltd. (Gulf) and Bahama California Oil Company, Ltd. (California Standard). The license of Nassau Oil Mining Company, Ltd., expired. Several companies have made inquires regarding petroleum activities and legislation during the course of the year.

BAHRAIN

Prod. 31,000 b/d **R. C. 186,500 b/d**

A 25,000 b/d vacuum unit is under construction at refinery of Bahrain Petroleum Company, Ltd. (Caltex). This company is only operator on this island in the Persian Gulf.

BARBADOS, B. W. I.

R. C. 240 b/d

Barbados Gulf Oil Company, Ltd., holds a prospecting license over about one-half of the Island of Barbados (north of Trinidad), which also extends into portions of the territorial waters adjoining. The company's first wildcat test, Gulf Turner Hall No. 1, started in 1953, was drilled to 11,352 ft, but did not find commercial production.

Gulf Ince No. 1, spudded August 25, 1954, was temporarily abandoned November 19, 1954, at 5078 ft. After testing some shallow gas. Gulf Adams Castle No. 1 southwest of Bridgetown, was drilling at 710 ft at end of year.

British Union Oil Company, Ltd., on August 1, 1954, was granted a prospecting license for the balance of the island, including some territorial waters and is carrying out a geological reconnaissance.

Some 7600 b/d products and 60 b/d crude oil is imported.

BELGIAN CONGO

Petrofina, Belgian firm, is said to be acting as drilling contractor for state and private interests and has spudded in on the first location between Stanleyville and Coquilhatville. The African territory imports some 10,000 to 12,000 b/d oil products.

BELGIUM

R. C. 95,000 b/d

At Antwerp, the refinery owned jointly by British Petroleum and Petrofina, commissioned a polymerization plant in December, and a catalytic cracking plant will be ready in spring 1955, when capacity will be increased to 54,000 b/d from the present 36,000 b/d.

BOLIVIA

Prod. 6,000 b/d **R. C. 10,500 b/d**

Bolivia has been busy in 1955 developing markets and transportation for surplus productive capacity. The country's requirements of almost 4000 b/d is oversupplied and refineries run less than capacity.

A 150-mile 6-in. pipe line to cost $3,900,000 is now being laid by Williams Bros. from Camiri to Yacuiba, on the Argentine-Bolivian border. This is near the Glenn McCarthy concession and he has agreed to supply when available, up to 10,000 b/d to YPFB, the government petroleum agency, for this line and other uses. Two other neighbors—Chile and Brazil have signed agreements for Bolivian oil in exchange for goods. A pipe line to Chile is under discussion. Negotiations are being conducted with Paraguay and Peru for more sales.

Petroleum exports are expected to bring in some $6,000,000 in 1955.

Bolivia's nationalization of tin mines and other resources has discouraged foreign investment although recently there has been an attempt to point out that "policies of nationalization were limited in scope." McCarthy, with two rigs in the Los Monos area, has two producing wells and other companies are said to be interested. The third test McCarthy is drilling on Agua Salada structure is scheduled for 13,000 ft. The second test came in at 4508 ft with 100 b/d light oil and considerable gas.

YPFB found a new sand at Camiri which brought reserves to 50,000,000 bbl. Production is held down at present but should climb quickly as soon as the pipe line is completed. The company has 7 drilling rigs in operation, making 9 in the country.

BORNEO (British)

Prod. 99,470 b/d **R. C. 45,000 b/d**

British Borneo consists of two Colonies (North Borneo and Sarawak) and a Protectorate, the State of Brunei. Shell Group companies are active in each of the three territories.

In **North Borneo,** during 1954, Shell completed an extensive gravity survey in the Dent Peninsula, on the East coast. In the Klias Peninsula, on the West coast, a test wildcat was abandoned as a dry hole at 8438 ft.

In **Brunei,** at **Seria,** The British Malayan Petroleum Company continued to work and develop the oil field, which throughout 1954 produced an average of 98,100 b/d. This was slightly less than during 1953, as a reservoir conservation program got into stride. Exploration continued throughout the hinterland of the state, and deep exploration drilling proceeded in the Labi area.

Seria's first marine drilling platform, a mile off the coast, had four producing wells drilled from it into the bed of the China Sea, and by year's end work was far advanced on the erection of two similar platforms elsewhere along the Seria coastline. A fourth platform is planned.

Preparations were in hand at the end of 1954 to resume exploration drilling in the Jerudong area of Brunei, where a certain amount of shallow exploration took place in the years immediately before the outbreak of World War II.

In **Sarawak** the throughput of Lutong refinery was maintained at about 45,000 b/d, and production of the nearby Miri oil field was increased slightly to 1370 b/d as a result of stepping-up work-over operations. Exploration teams were active throughout Sarawak, and exploration drilling is in progress at Pasir and Suai. A drilling location was in preparation in the Tatau River area, where 3 or 4 wildcats are planned for 1955 and subsequent years.

BORNEO (Indonesia)

Prod. 15,000 b/d (?) R. C. 48,000 b/d (?)

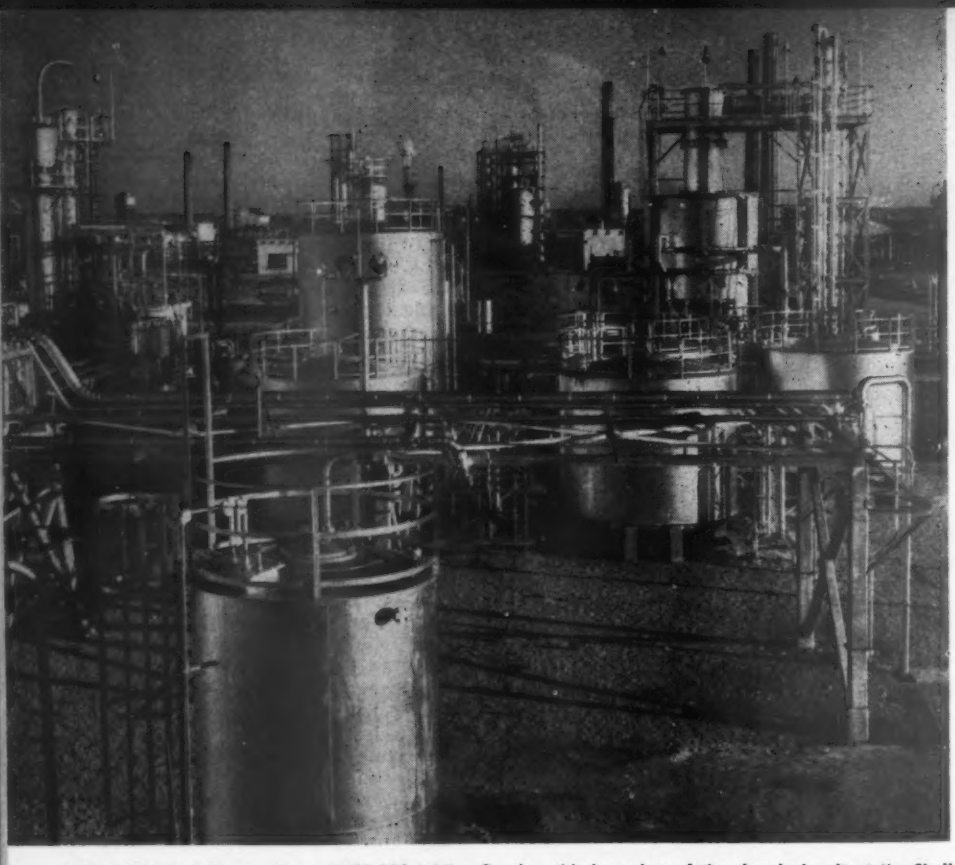
The Indonesian Government has not encouraged foreign investment. The Balikpapan refinery and small fields are operated by Shell, although nationalized.

BRAZIL

Prod 3000 b/d **R. C. 42,000 b/d**

Brazil's oil and gas resources are buried under strict nationalist policies but only capital investment and technical skill can reveal the potential resources, which are thought to be extensive.

Only Petrolras, the state oil monopoly, can produce or refine petroleum. Ownership of refineries already operating or planned by private interests, however, were left in the owners' hands. Petrolras has a 5000-bbl refinery near Santos at Cubatao being expanded to 45,000 b/d capacity. It is expected to be completed soon and more capacity will be added in 1956 (to 75,000 b/d) and in 1957 (to 90,000 b/d). Repediral is building a 10,000 b/d refinery at Rio de Janeiro.



Part of one of France's largest (70,000 b/d) refineries, this is a view of the chemical unit at the Shell Berre plant near Marseilles. *Shell photo.*

Brazil's lack of initiative in developing its resources does not hold down its rising demand, which increased about 15 per cent in 1954. Imports of about 155,000 b/d were a costly payment for the economy, amounting to 16 per cent of the total import bill.

The State of Bahia has the only production. Eight fields in the Reconcavo area have estimated resources of 15,000,000 bbl and produce about 3000 b/d.

BULGARIA

R. C. 2500 b/d (?)

USSR retains control of oil operations in Bulgaria.

BURMA

Prod. 4250 b/d **R. C. 4000 b/d**

Total oil production in Burma during 1954 (including a small quantity taken from Yenangyaung by local operators) amounted to about 1,550,000 bbl, a daily average of some 4250 b/d. This is comparable with the estimated daily average for 1953 of nearly 3300 b/d.

Production drilling at Chauk continued on a limited scale but owing to the unsettled conditions in Burma, prospecting could not be carried out.

After the signing in January of the agreement between the Burmese Government and the British-owned oil companies in Burma, a new Burmese company—The Burma Oil Company (1954) Ltd., was formed. Plans are under way for the construction of a refinery near Rangoon with a capacity of 4000 b/d. With the Chauk refinery's (4000 b/d) can fill local demand.

CAMEROUNS

Two geophysical crews of a French company are operating in this West African territory. The one drilling rig put down 7 wildcats, all dry, although new evidence of oil and gas were encountered.

CANADA

Prod. 265,750 b/d **R. C. 560,000 b/d**

Western Canada still has a shut-in capacity that would probably balance the nation's high per capita demand (second only to U. S.) if distribution were economic.* It did increase production some 20 per cent over 1953.

Some 230 rigs drilled 2260 wells in 1954. Some 372 million barrels oil reserves were added to make 2,416 million barrels at the end of 1954.

Developments in 1954 saw Pembina area recognized as having largest reserves in Canada. A 78-mile 16-in. crude oil line was being laid from Pembina to Edmonton terminals of Interprovincial and Transmountain.

Saskatchewan and Manitoba came in for expanded exploration and drilling activity. Saskatchewan created a market in Minnesota for about 25,000 b/d of crude. Manitoba had a sharp production increase. Nearly all promising territory in Alberta Province was leased and operations were in progress.

Objections to a natural gas line to markets on the West Coast weakened some and plans were going forward on two great gas lines—Westcoast and Trans Canada. Two gas lines—from Detroit and Ft. Erie—were built to Toronto to supply that area with Texas gas.

Refinery expansion goes on at great pace. British-American is adding a fluid cat cracker to its Clarkson, Ontario plant and McColl-Frontenac a thermal cracker at Edmonton. Canadian Petrofina is building a 20,000 b/d refinery at Montreal, Quebec; North Star Oil, a 12,000 b/d plant at St. Boniface, Manitoba; Imperial is adding a 2000 b/d lube plant at Edmonton, Alberta, and is expanding its refineries at Montreal and Halifax.

CHILE

Prod. 4500 b/d **R. C. 20,300 b/d**

Empresa, state oil monopoly, may allow foreign companies to explore and develop oil resources. Firms would operate on a contractual basis.

So far all production comes from Tierra del Fuego and north of Straits of Magellan. Empresa has 6 rigs in operation and is making a test in Central Chile.

Chile consumption runs about 11 million compared to the 1½ million barrels the country produces. The 20,000 b/d refinery at Concon, built by M. W. Kellogg for Empresa, will save about $10,000,000 a year on Chile's bill for oil products but costs of state oil activities have far outweighed any return so far. Pipe lines for products and gas from Concon to Santiago are being planned.

CHINA (Communist)

Prod. 3000 b/d **R. C. 10,000 b/d (?)**

Reports are unreliable but, for what they are worth, new fields are reported in Tsinghai Province and in Sinkiang. Formerly most production was from Kansu. All operations are carried out by a joint Soviet-Chinese company, which was supposed to be turned over to China, January 1955.

The U. S. Bureau of Mines continues to estimate both production and refining runs at about 2000 b/d as it has for 5 years. It is hard to judge capacity as no one knows the condition of pre-communist refineries. Oil is undoubtedly among the largest imports. A government report said a new cracking plant went on stream in Sinkiang Province recently, equipped with latest Russian machinery.

COLOMBIA

Prod. 108,000 b/d **R. C. 40,000 b/d**

Six leading companies in Colombia, Intercol (Jersey Standard), Shell, Texas, Ecopetrol, Colpet (Socony) and Richmond (Standard California) are operating 20 rigs in the country, according to Dr. Eduardo Osping-Racines, petroleum economist with headquarters at Bogota. Richmond drilled the deepest wildcat in the country to 15,539 ft, where it was abandoned in July.

Besides crude oil production, Colombia has some 111,000 b/d condensate output.

Completion of the Barrancabermeja refinery was the highlight of the year. The 35,000 b-d plant cost $44,000,000 and is operated by Intercol for Ecopetrol (Empresa Colombian de Petroleos).

Colombia recently became an official observer of the Interstate Oil Compact Commission.

COSTA RICA

Surface geological exploration by two parties of Union Oil Company of California on the 3,000,000-acre exploratory concession in Costa Rica, led to the commencement of drilling operations in October, 1954, and at year end the first well, Patino 1, was drilling at 5038 ft. The well is on the southeastern coastal plain.

CUBA

Prod. 200 b/d **R. C. 8000 b/d**

Cuba is the Cinderella of 1954, suddenly hitting the limelight when a well drilled by Kerr-McGee for Cuban independents came in at 100 b/d in the Jatibonico Basin. A government inspector, Florent H. Bailly, reported electric logs showed 37 oil zones. Two offsets completed were better than the discovery.

Several major companies—Gulf (which has already spent $5,000,000) Atlantic, Shell, Jersey Standard, Standard of California—and numerous smaller companies, such as Corporacion General de Petroleo, which made the 1954 discovery, Cuban-

*See "Canadian Output Could Balance Consumption," Floyd K. Beach, *The Petroleum Engineer*, February 1955, Page A-61.

Venezuela Oil Voting Trust, Cuban-Canadian (American-Leduc), and a dozen or more others. Sixty geologists are said to be at work and three rigs are in operation.

Some 32 wildcats have been drilled since 1930 with only the small Jatibonico field with 5 producing wells to show for it. Cuban-Canadian, part owner of the field, drilled one producer and one dry hole in 1954 and is now drilling two more wells.

A number of wildcats are planned for 1955 by various companies.

A Socony refinery at Olean, New York, was bought by C. J. Simpson (Drilling Company) to be dismantled and moved to Cuba. This will help toward the 55,000 b/d products requirements for the Cuban Republic.

To stimulate developments, the government reduced exploration rentals, exempted various taxes, and offered exploration loans for drilling.

CURACAO, N. W. I.

R. C. 200,00 b/d

Shell's new lube oil plant capacity is 3500 b/d instead of 2100 b/d as stated in last year's "Round-Up." The company is planning a new cracking unit for its large refinery here. In mid-1954 crude intake was 307,000 b/d including crude oil intake to cracking plants (100,000 b/d capacity).

Some drilling said to be going on here by local interests.

CZECHOSLOVAKIA

Prod. 3500 b/d (?) R. C. 5000 b/d (?)

Figures are a guess. No reports have been given.

DENMARK

R. C. 750 b/d

Danish American Prospecting Company (Gulf) still holds only concession here. A geological study was continued.

ECUADOR

Prod. 8750 b/d R. C. 5300 b/d

Anglo-Ecuadorean Oilfields and Manabi Exploration Company, the only oil operators in Ecuador, have developed their fields and raised production some but exploration has been discouraging. Nine rigs are in operation.

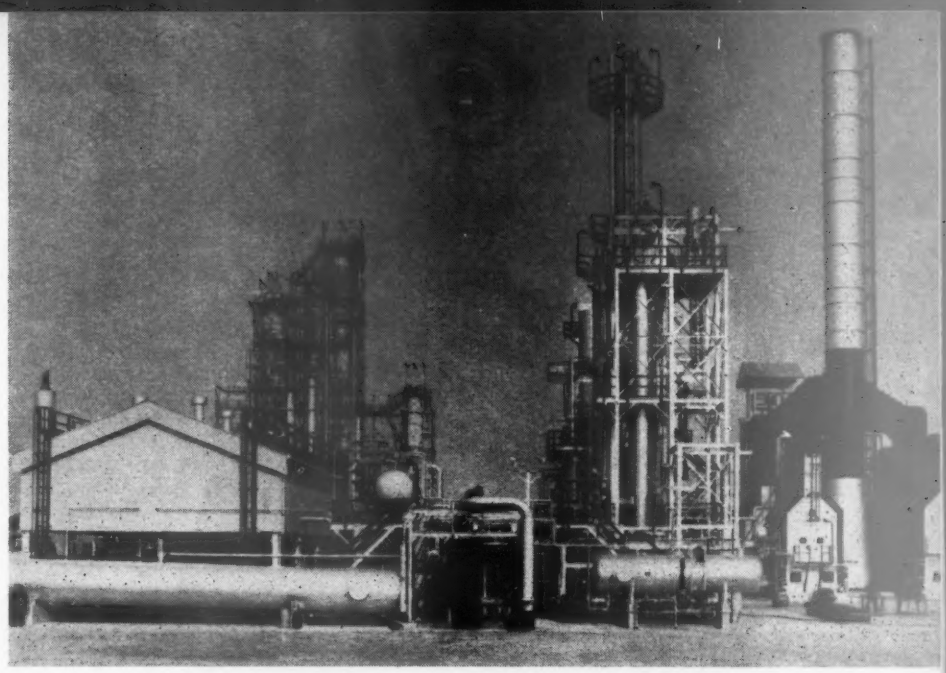
Manabi's major wildcat went 9792 ft for a record depth on the Santa Elena Peninsula. It failed to find commercial production.

Runs to refineries are less than capacity. Anglo-Ecuadorean is about 300 b/d less than the 4800 capacity of La Liberdad plant. Manabi has a 430 throughput at its 500 b/d plant at Cantivo. Products imported run about 3000 b/d.

IN APPRECIATION

For information in this eighth annual survey of foreign oil operations, we are indebted to many companies, to government agencies, and to individuals. Outside of Communist-dominated countries, we received reports from most government councils or bureaus responsible for petroleum development. Oil companies operating abroad supplied a large amount of essential data on their operations in various countries. A number of individuals provided information that was helpful in this task of compiling a review of work during 1954 of the oil industry outside the United States. To all of them we wish to express our deep appreciation.

—Ernestine Adams



Platformer unit at Hamburg, Germany, refinery. Capacity was increased to 25,000 b/d crude intake.
British Petroleum photo

EGYPT

Prod. 40,000 b/d R. C. 47,000 b/d

The new Egyptian Government and several oil companies made several significant agreements in 1954 and negotiations are in progress on other contracts, which may change the adverse trend of the country's oil development.

Egypt's largest import is oil products —some 24,000 b/d—but the government in recent years has thrown impossible obstacles in the way of developing its own resources. Fields on the Sinai Peninsula and on the west shore of the Red Sea have kept up fairly well. Shell and Socony supply half the production.

Only discovery of the year was that of National Petroleum Company of Egypt, owned by Southern California Petroleum, International Egyptian Oil Company, and Swiss and Belgian interests, at Wadi Fevian on the Sinai Peninsula.

For the first time a concession covering the West Desert was granted. The Egyptian Government authorized Conorada (Continental, Ohio Oil, and Amerada) to carry out oil exploration over an area about the size of Nebraska. A minimum expenditure of $3,000,000 is called for during first 3 years. Cities Service and Richfield will share in the exploration and development of the area. Four geological crews, two seismograph and one gravity meter parties are in the area.

Current refinery runs at Anglo-Egyptian Oilfields' refinery are 36,000 b/d, under the 40,000 b/d capacity.

Egypt's consumption is rising at the rate of 10 per cent a year.

ETHIOPIA

Sinclair Oil Corporation is continuing exploratory activities in this country. It holds the only concession.

FINLAND

Finland consumed about 20,000 b/d petroleum products in 1954, almost 30 per cent more than in 1953. Virtually all these imports come from Russia and Romania.

A 15,000 b/d refinery is planned for a seaport near Turku by a company in which the government has a major interest. Cost is estimated at $18,000,000.

FORMOSA

Prod. 100 b/d R. C. 10,000 b/d

A 6500 b/d cracking unit is to be added to Kaohsiuna refinery which has a 10,000 b/d crude capacity. It is being built by Fluor Corporation for the Chinese Petroleum Corporation, Nationalist oil monopoly. Middle East and Far East crudes will be processed.

Considerable exploration has been carried out recently and some small wells are producing.

FRANCE*

Prod. 10,000 b/d R. C. 610,000 b/d

France had an exciting year. Its biggest field was discovered south of Bordeaux by Esso Standard Francaise (Jersey 63.2, Gulf 18.3, French investors 18.5 per cent). Test on a 1-in. choke produced 16,000 b/d of light oil at Parentis No. 1, discovery well. Five wells are shut down to 6000 b/d at present.

The first oil discovery in Paris Basin, north-central France, was made by Regie Autonome des Petroles, north of Beauvais. It is a heavy oil in the Pays de Bray and so far is not commercial but four wildcats were drilled and encouraging indications were formed.

Ten geological parties and 18 geophysical crews are operating in France. Petroleum development laws were improved in 1954 and many new requests for exploratory and drilling permits were filed.

Twenty-five rigs (12 heavy rigs) drilled 57 wells in 1954, bringing in 15 oil wells and one gas well.

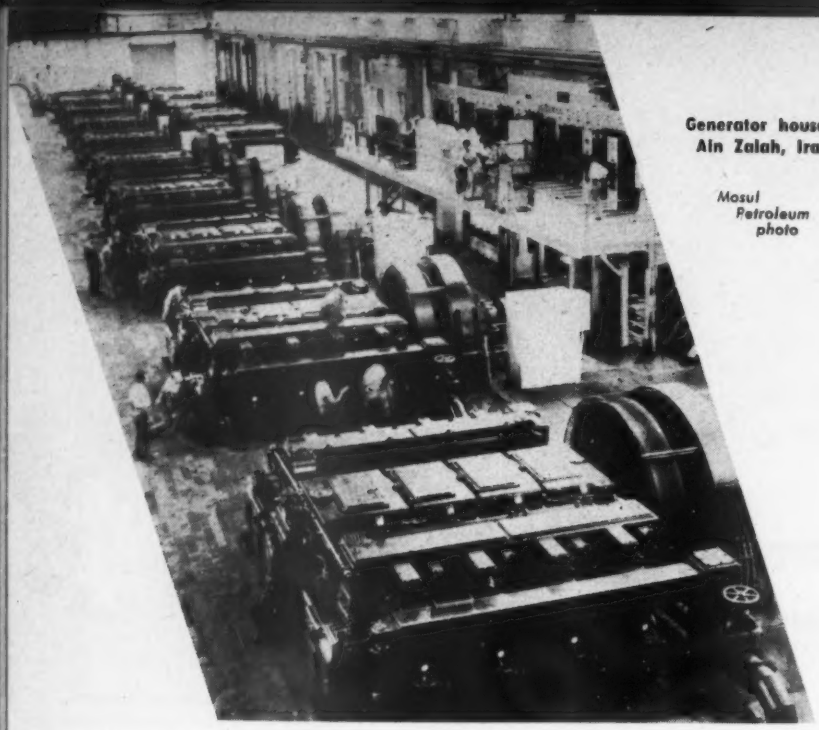
Saint Marcet gas field continued to produce about 25,000 mcf/d and almost 1000 b/d condensate.

Lacq field, now second to Parentis, averaged about 5700 b/d in 1954. Socite Nationale des Petroles d'Aquitaine, which developed the field, reached a deep gas sand with two wells in 1954, both shut in.

Some refining capacity is not used. Runs in 1954 averaged 530,000 b/d. Societe Francaise des Petroles has commissioned a UOP platformer unit at Lavera, which has 40,000 b/d capacity. Campagnie Francaise de Raffinage is planning a cat cracker at Confrereville. Shell is adding an 8000 b/d cat cracker to its 50,000 b/d plant at Petit Couronne to be completed in 1956.

France has about 5000 miles of crude

*Excellent background material is contained in "Petroleum Exploration and Development in France," Dr. J. Dupony-Camet, *The Petroleum Engineer*, April 1952, page, B-58.



Generator house at Ain Zalah, Iraq.

Mosul Petroleum photo

oil lines and 155 miles of gas lines. None are being built at present.

FRENCH EQUATORIAL AFRICA

Two rigs operating in this territory drilled 9 wells in 1954, 2 of which were deep. All were abandoned. Five geological crews and three geophysical crews are working.

Indications of oil and gas were found in the Gabon, where drilling was near the numerous salt domes.

FRENCH WEST AFRICA

France's Bureau de Recherches de Petroles has two geological and one seismic parties in French West Africa. Senegal (where Dakar is located) has a large sedimentary basin. A well drilled about 300 ft found oil indications and a deeper hole is being drilled by the one rig in the area.

GERMANY (West)

Prod. 55,000 b/d R. C. 220,000 b/d

West Germany in 1954 had doubled its oil production of 1951. Intensive search and drilling (about 600 wells in 1954 drilled by 188 drilling rigs) have built up many small producing areas. Some 2500 oil wells in 40 fields produce 54,000 b/d toward meeting increasing consumption.

Much of the production is owned by private German interests but development has been furthered by foreign companies such as Shell, Jersey, Socony, etc. Socony checked up an important find in 1954 in the Molasse Basin at Ampfing, close to the Austrian line. Initial production was 4500 b/d of gravity. The basin extends along the northern rim of the Alps and offers a promising area for exploration.

Although West Germany must import crude oil to supplement demand—110,000 b/d in 1954—refining capacity is high enough to balance products imports with exports.

Actual runs were some 170,000 b/d in 1954 and consumption hit about 150,000 b/d.

British Petroleum completed a new distillation unit in March at its Hamburg refinery, raising capacity to 25,000 b/d and commissioned a UOP platformer. The Gelsenburg refinery at Gelsenkirchen also has a new platformer unit.

GREECE

George Armistead and Company is acting as technical consultant to the Greek Government in connection with plans for a 30,000 b/d state-owned oil refinery.

C. Dielmann G mb H, a German firm, is conducting exploration operations in Eastern Thrace in a joint venture with Ilios, a Greek concern.

About 26,000 b/d petroleum products are imported in this country.

GUATEMALA

New laws regulating oil exploration and drilling are being studied. One proposal specifies that companies will qualify if not less than 30 per cent of the capital is offered to citizens. Formerly 60 per cent of the capital had to come from Guatemalans. President Carlos Castillo Armas, who ousted the procommunist regime of Arbenz, would like more capital invested in his country.

Guatemala imports more than 5000 b/d products.

HAITI

Fitzpatrick Company has the only contract for oil exploration in this West Indies island.

HAWAIIAN ISLAND

R. C. 3000 b/d

Pacific Refiners had an average throughput of 2800 b/d in 1954 at its Honolulu refinery. Crude is imported for the industry.

Standard of California is planning a 20,000 to 30,000 b/d capacity plant near Honolulu.

HONDURAS (British)

British Honduras Gulf Oil Company completed its seismograph program during the first half of the year and were making preparations toward the end of the year for the drilling of its first wildcat test expected to spud about midyear 1955.

HUNGARY

Prod. 10,000 b/d (?) R. C. 35,000 b/d (?)

USSR is reported to have agreed to sell its share of Masovol, the USSR-Hungarian oil company, back to Hungary, payment to be made from production. The oil fields were developed by Jersey Standard, taken over by the Russian Communists and are now sold to the Hungarian Communists.

INDIA

Prod. 6120 b/d R. C. 37,000 b/d

India's consumption rises slowly. It ran about 68,000 b/d in 1954, more than a third of the demand was for kerosine. Total consumption was up less than 5 per cent over 1953.

Assam Oil Company (Burma Oil) so far the only firm having oil production, increased its output at Nahorkatiya, west of Digboi in 1954, and maintained Digboi field production. Four wells were drilled to about 10,000 ft at Nahorkatiya and three produced about 500 b/d each. An 8-in. line from this field to the Digboi refinery was opened November 22.

Geophysical work over the Upper Assam Valley area was continued during 1954 by the company. Two seismic crews, assisted by helicopters, were still working at the end of the year. Assam, Standard-Vacuum and Caltex are engaging in some exploration work in the Bengal Basin.

The 25,000 b/d Standard-Vacuum refinery at Bombay went on stream in August, a boom to India, which could import that much crude instead of products.

The Burmah-Shell refinery of 40,000 b/d capacity, also at Bombay, will soon go on stream. Caltex will begin construction in 1955 on the 10,000 b/d refinery at Vizagapatam.

The $125,000,000 required for these refineries was chiefly supplied by the oil companies.

A lubricating oil distillation plant is planned for the Assam Oil's Digboi refinery. Until this year the 6000 b/d refinery was the only one in India.

INDONESIA

Prod. 208,000 b/d R. C. 210,000 b/d

Shell, Standard-Vacuum and Caltex operate in this region. Standard-Vacuum plans a $70 to 80 million expansion plan on its concessions in the islands. The other companies also have extension plans for future operations. See details under Java, Sumatra, and Borneo.

IRAN

Prod. 170,000* b/d R. C. 575,000 b/d (?)

Iranian oil has had world political and economic influence out of proportion to its size and value. It lured the Soviet to occupy the country and caused them to retreat. It made the odd Massadegh a dictator and in turn threw him out. It crushed the Anglo-Iranian Oil Company in Iran but made it a stronger competitor in other parts of the world.

In 1954 Iranian oil entered an era of calm. A settlement advised by Herbert Hoover, Jr., put the fields back into production, the Abadan refinery back into processing, and the output of both back in the world markets.

A consortium of eight oil companies undertook to produce and market the oil. The Iranian Government agreed. It became effective October 29, 1954.

British Petroleum holds 40 per cent of the consortium; Jersey, Standard of California, Texas, Gulf, and Socony, have 40 per cent among them (5 per cent is to be sold to "qualified independents.") Shell holds 14 per cent and Cie. Francaise des Petroles has 6 per cent.

According to the agreement, British Petroleum (whose properties were confiscated) will receive L 25 million from the Iranian Government over a period of 10 years and L 32.4 million from other companies in the consortium within a year besides a small royalty.

Daily average in January, 1955, was 227,000 b/d production and refining runs were 151,000 b/d.

*Average for December only.

IRAQ

Prod. 614,000 b/d R. C. 16,000 b/d

Iraq Petroleum Company (Kirkuk field) produced 493,400 b/d. Light oil was discovered at Jambur 35 miles southeast of Kirkuk, where two wells were successfully drilled to 5700 ft and at the turn of the year other wells were being drilled. At Bai Hassan, where oil was discovered in 1953, a fourth well was completed, with a fifth well drilling. The company has 41 producing wells.

In the area of the Basrah Petroleum Company, which produced 94,900 b/d production began from the new Rumaila field towards the end of the year. Rumaila is 20 miles west of Zubair, to which it is linked by a 12-in. line laid in 1954. The 38th well was completed at Zubair, as was the fifth well at Rumaila; 25 wells are producing.

An extensive exploratory drilling program was set by Mosul Petroleum, which produced 25,900 b/d in 1954 from only 6 wells.

Nine rigs are operating in Iraq for all 3 companies. Of the 14 wells drilled in 1954 only one was dry.

Under a 50-50 agreement the three companies paid nearly $150,000,000 to the Iraq Government in 1954. Construction has begun on a 24,000 b/d refinery near Bagdad, which the Government has contracted with Kellogg International to build.

ISRAEL

R. C. 85,000 b/d

By the end of 1954, 38 licenses were held by 8 companies which were continuing exploration work with 6 geological crews and 2 geophysical parties. Five rigs were operating and 6 wells were drilled in 1954 on the Carmel Range, in the lower Coastal Plain, in the central Coastal Plain, in central Negev and in the Dead Sea area. Although no production has so far been found, several shows of gas and heavy oil were encountered. The aggregate depth drilled up to the end of December, 1954, was 27,000 ft. Further locations have been selected by the companies for a number of additional tests.

Crude runs to refinery were 6,500,000 or 18,073 b/d; consumption 8,600,000 or 23,544 b/d (of which about 25 per cent was handled by a local company).

The State is operating under petroleum laws suggested by the late Max Ball. U.S., Belgium, Canadian, Swiss, and Isreali are among those having interests in concessions.

The Haifa refinery continues to run under capacity. The Arab League has not relaxed its blockade of Middle East oil to the plant. Imports did come only from Venezuela but 1954 saw trade exchanges for crude from Russia and Romania.

The 144-mile products line from Haifa to Tel-Aviv is still in the planning stage.

ITALY

Prod. 3000 b/d R. C. 450,000 b/d

In 1953 a Gulf subsidiary found oil in Sicily; early this year (1955) Petrosud (Gulf and Montecantine) brought in a 2000 b/d well in Cigno area of Italy 16 miles from Pescara, and ran headlong into the rigid wall of State corporations.

In Sicily, an autonomous region, laws permit foreign capital to get a run for its money, a try for profits. In Italy the state-owned Ente Nazionale Idrocarburi (ENI), established by Mussolini, holds sway over all petroleum operations.

In 1954 Gulf Italia Company completed 7 party months of seismic work and 12 party months of field geology in the Abruzzi area of the Adriatic Coast.

ENI has never been succesful in oil operations but has done well in expanding gas resources. ENI produces more than 105 billion cubic feet a year and it is a big factor in the economy of Northern Italy, although high in price. In Milan ENI has built a "City of Gas" with a school to study hydrocarbons, houses, hospital, hotel, bank and church.

Many government men would like to see competition opened up and private capital drawn into the expensive job of finding and developing petroleum resources but they have found, as many before them, that a government agency is entrenched.

Meanwhile refining capacity is expanding despite the fact that it is already more than domestic demand and export market combined. Crude runs were less than 350,000 b/d in 1954.

British Petroleum and Azienda Generale Italiana Petroli are adding a platformer unit to their Porto Marghera refinery at Venice. It will have a 1750 b/d capacity. The refinery's present capacity is 28,000 b/d.

Italian Production of Crude Oil
(Thousands of barrels)

Year	Total	ENI	% of total
1951	145	115	79
1952	463	432	93
1953	596	584	98
1954*	253	252	99

Italian Production of Gas, MCF
(Millions of cubic feet)

Year	Total	ENI	% of total
1953	81,139	71,376	88
1954*	30,069	27,963	91

*Half year.

JAPAN

Prod. 5900 b/d R. C. 150,000 b/d

More than half of Japan's import bill is for crude oil and oil products and the need continues to increase. Demand was an estimated 16 per cent higher in 1954 than in 1953.

Despite earnest endeavor, production from Japan's small wells (about 3000 are productive) cannot be greatly expanded. Resources are carefully developed and conserved. Japan has one of the first secondary recovery projects in the Eastern Hemisphere.

Refining capacity is expanding. Showa Oil's Kawasaki refinery put a 1300 b/d platformer on stream in March and Mitsubishi Oil's Kawasaki refinery placed a 1500 b/d platformer on stream in August, 1954. Maruzen Oil is constructing a new 3000 b/d cracking unit and gas concentration plant at Tokyo.

JAVA (Indonesia)

Prod. 13,000 b/d (?) R. C. 5000 b/d (?)

Shell maintains some working contact in Java. Political difficulties hamper any development at present. Refinery at Tjepoe is close to Rembang fields and Wonokramo and Bendoel plants are in the Soerabaja fields.

KENYA

The Geological Survey began the revision of the area covered by F. M. Ayers at the beginning of 1953. Mapping is being done with a view to publication on the 1:125,000 scale. By the end of 1954 all the part of Kenya east of the 40th meridian and north of second parallel had been mapped, and five reports for publication are in preparation.

A 4-year oil exploration license was granted January 20, 1954, to the Shell Overseas Exploration Company, Ltd., and the D'Arcy Exploration Company, Ltd., covering the area east of 39° 30'E and south of the Equator and the Somalia border, including the off-shore islands and extending to the seaward limit of the territorial waters. Geologists and geophysicists of the two companies are carrying out surveys in the area.

KUWAIT

Prod. 965,000 b/d R. C. 30,000 b/d

The most fabulous 6000 sq miles in the oil world is the sheikdom of Kuwait, which went over a million barrels a day production in 1954 and an average of not much

Gas pipeline crossing of the Dora river near Ivrea in northwest Italy. ENI, state-owned company, has been successful in expanding gas resources.

Ente Nazionale Idrocaburi photo

In Papua two bomb scows carry men, supplies and equipment along a narrow creek to quarters of a survey party in the jungle.

British Petroleum photo

less. Reserves exceed 20 billion barrels.

Kuwait Oil Company (owned jointly by Gulf and British Petroleum) has the concession. The wealth paid to the ruler is reaping an outstanding gain in education, health, and general well being among the country's subjects.

KUWAIT-SAUDI ARABIA NEUTRAL ZONE

Prod. 25,000 b/d

In the Kuwait-Saudi Arabia Neutral Zone, American Independent Oil and Pacific Western Oil have launched a program of development drilling in the Wafra field. At the end of 1954, with 2 rigs, a total of 15 producing wells had been completed with an aggregate capacity on the order of 25,000 b/d of 24 gravity crude. Total recoverable reserves have been estimated to be on the order of 320 million barrels.

During 1953 Aminoil completed a gathering center at the Wafra field, a 34-mile pipe line, and a shipping terminal on the Persian Gulf of Kuwait, known as Mena Abdulla. The first tanker shipment of Wafra crude oil was made early in January of 1954.

In November, 1954, a deep test in the center of the Wafra field encountered a significant productive section, known as the Ratawi limestone, at a depth of 6779 ft. Present production comes from the Burgan sand at about 3500 ft.

LEBANON

R. C. 11,000 b/d

Lebanon, a small nation huddled on the west Mediterranean shores, has discouraged oil explorers. Pacific Western and a Lebanese corporation were the last to abandon attempts to find petroleum.

But the Trans Arabian Tapline and the Iraq Petroleum lines from north Iraq to Tripoli pay for exporting oil through the state. Under proposed raises the payment would be more than $2⅓ million a year, or about one-tenth of the country's budget. The agreement is held up because the Lebanese want more.

At Tripoli, Iraq Petroleum is planning expansion of its refinery. At Sidon, Mediterranean Refining Company (Caltex and Socony) is building a 9000 b/d refinery, part of which was completed this year. The plant cost about $8,000,000. Procon Incorporated is constructor.

MADAGASCAR

Societe des Petroles de Madagascar is drilling a widcat in the basin with a heavy Wilson rig. The well is about 8000 ft deep and has gas shows.

Four geological crews and four geophysical crews worked during 1954. The latter were two gravity meter parties, one seismograph and one air magnetometer survey.

MALTA

Exploration rights were obtained by D'Arcy Exploration Company, and a geological survey has been completed in this British territory.

MEXICO

Prod. 235,000 b/d R. C. 200,000 b/d

Antonio J. Bermudez, general managing director of Petroleos Mexicanos, state oil monopoly, has proved the rule that state oil development is unsuccessful by being the exception. The important factor seems to be that Bermudez is first an oil man and second a politician, although in his job, he has to be both.

No one can compare, of course, where Mexican oil development would be now if properties of private companies had not been expropriated in 1938. In 1954 production reached its peak since 1938. Top production was in 1921 when the average was 530,000 b/d but it fell in the depression to as low as 90,000 b/d in 1932 before expropriation.

Nearly 100 rigs are working in the country and exploration is being intensified. Main production is now along the east coast but potential of Chihuaba, Coahuila, Baja, California, and Yucatan are favorable.

Reserves of oil and natural gas amount to almost 2½ billion barrels.

A refinery and pipe line expansion program is in progress. Refinery expansion is being carried out at Atzapatzalco, Salamanca, Poza Rico, Minatitlan, etc. Gas processing plants are receiving special attention with growth of gas reserves.

Mexico not only supplies its own rising demand but exports some crude oil.

MOROCCO

Prod. 2445 b/d R. C. 3500 b/d

Societe Cherifienne des Petroles has continued to explore the Rharb region and and has undertaken the exploration of the Middle Moulouya Basin. Two geological parties and two seismic crews are working.

Fields of the Oued Beth have been extended toward the Northeast. In these fields 95 wells are producing, 9 new producers being drilled this year. The 7 rigs in the country drilled these 9 wells and 47 dry holes in 1954.

The company's refinery at Petitjean was expanded to 3500 b/d at end of year with new TCC unit. Average runs for 1954 were 2400 b/d.

Morocco needs further development to meet its needs. Imports average 17,000 b/d.

MOZAMBIQUE

Mozambique Gulf Oil Company continued geological and geophysical studies throughout the year in this East African Protectorate (Portugal). There was no drilling.

NETHERLANDS

Prod. 18,000 b/d R. C. 200,000 b/d

Nine rigs are operating in Holland, and 22 wells were drilled, 19 in Schoonebeek with 17 producers; 2 in Rijswijk with one producer, and oil was discovered at Delft at 4000 ft. The well averaged 49 b/d of 32 gravity oil in July. Schoonebeek, with 244 wells, produces most of Holland's oil. Wells were drilling in all three fields at the end of 1954.

Shell and Jersey Standard, whose subsidiary has the only producing properties, have entered an agreement with four German companies to develop the gas fields at Frenswegen and Denekamp in the Netherlands and Itterbeck and Tubbergen across the line in Germany.

Shell and Caltex each has a refinery at Pernis, near Rotterdam. Runs are about 15 per cent below capacity. Shell is expanding its luboil unit to 1750 b/d and building a 33,000 b/d cat cracker.

Consumption in this country increased nearly 13 per cent in 1954 over 1953.

NEW CALEDONIA

One drilling rig drilled four dry holes on this Pacific island (French), lying east of Australia.

NEW GUINEA (Neth.)

Prod. 20,000 b/d

Production at Klamono field, operated by Shell, has been expanded since a pipe line was built to expedite shipping. Caltex and Standard-Vacuum also hold interests in the field.

An Australian firm is exploring the Sepik River area. Exploration so far has been expensive and unsuccessful.

NEW ZEALAND

Prod. 50 b/d R. C. 80 b/d

During 1954, 42 oil prospecting licenses covering 6824 sq miles were taken up but little work has been done on them. One geological and one geophysical parties are operating in the country.

Egmont Oil Wells, Ltd., drilled one well, which is producing about 16 b/d from 2225 ft. This was at New Plymouth, only producing area, which has 5 wells. The refinery there uses natural gas from the field and processes all the oil, which is sold locally.

New Zealand imports 29,000 b/d of oil products to meet its needs.

NICARAGUA

Cuban Oil Resins, Inc., has been granted an exploration license covering the entire country for three years.

NIGERIA*

Shell D'Arcy Petroleum Development of Nigeria found oil shows at Akata in Calabar Province when it went to 11,121 ft. Another well is going down in the same area. Reports are that the company (Shell and British Petroleum) also had oil shows at its Ituk Mbana test in the same province.

*Background in "Oil for Nigeria," *The Petroleum Engineer*, February 1955, page E-20.

NORWAY

R. C. 2000 b/d

The Esso Oil Refinery at Valloy was established in 1895 and is one of the oldest existing refineries in Europe. Destroyed in World War II, it was rebuilt in 1949 and reopened in 1950. It is a skimming plant with 8 stills running Venezuelan crude.

First refinery in the Philippines is this Caltex plant in Bauan. Shown are power plant, crude distillation unit, and in background, machine shop and other facilities.
Caltex photo

OMAN (and Muscat)

Cities Service (and Richfield) has a 30,000 sq mile concession here. The company had two geological crews working. In January, 1955, a rig capable of drilling to 12,000 ft, together with two shallow rigs for water drilling and necessary supplies and housing were delivered to Oman. Drilling for water has begun and Cities Service hopes to spud in a large stratigraphic test soon.

Petroleum Development (Oman) Ltd., associate of Iraq Petroleum, is surveying in the southeast coastal region of Muscat. This company holds a concession over both Muscat and Oman except for the Cities Service license mentioned.

PAKISTAN

Prod. 5340 b/d **R. C. 5000 b/d**

After a seismic survey in early 1954, Pakistan Petroleum, Ltd. (Burma Oil) began drilling at Sylhet in East Pakistan and at Uch in Baluchistan. This is fourth test in East Pakistan. The others were unsuccessful. Seismic work was carried out in the Potwar area of West Punjab and at Khairpur.

Standard-Vacuum has an agreement to explore for oil over about 20,000 sq miles, half in East and one in West Pakistan. The Government will supply 25 per cent of the cost and have a 25 per cent share of any oil.

In West Pakistan the Burma Oil subsidiary completed the 6th well in the Sui gas field in Baluchistan. The gas field is being developed to supply a pipe line being built to Karachi. The test in Zin, 30 miles away, was abandoned at 6383 ft; the gas found was not in commercial quantities.

Only production in Pakistan is at Punjab in the Potwar Basin operated by Attock Oil chiefly, although Pakistan Petroleum has some interest. Attock also has the refinery at Punjab.

In 1953 Pakistan imports of petroleum products were 21,000 b/d, an increase of 17 per cent over 1952.

PAPUA (New Guinea)

Australasian Petroleum Company Pty. Ltd. and Island Exploration Company Pty. Ltd. (both owned by British Petroleum), Vacuum Oil Company Pty. Ltd. and Oil Search Ltd., (an Australian organization) continued exploring for petroleum in the Australian Territory of Papua throughout 1954.

Field parties from these companies carried out 24 party months on geological surveys; 30 party months on seismic surveys, and 12 party months on gravity meter surveys.

Introduction of helicopters in December, 1953, for servicing geophysical parties operating in remote or over difficult terrains, enabled reduction of seismic party strength from 3 to 2 parties in mid-1954 without decrease in output.

During the year two wells. Island Exploration's Omati No. 1 and Omati No. 2 were drilling. On receipt of special fishing tools and high pressure wellhead assembly early in 1954, operations were resumed in Omati No. 1, which had been suspended during 1953 at 13,743 ft, after open hole had caved on tools near bottom on encountering high pressure gas. After abortive attempts to recover the lower part of the fish, this well was side-tracked through 6⅝ casing at 11,666 ft and the new hole stood at 13,780 ft at the year end. Omati No. 2, about two miles east of No. 1, spudded in on April 7, 1954, had reached 7879 ft by the year end.

Program for 1955 provides for geological surveys on a 3-party basis, 2 seismic parties and 1 gravity meter party over the year; completion of wells on the Aramia River, and on Kuru Creek to the north of the Kikori-Purari Delta.

PERU

Prod. 47,000 b/d **R. C. 47,500 b/d**

Under the 1952 Peruvian petroleum laws 50 per cent of an exploration acreage must be surrendered within 5 years. The new law was liberal enough to bring about 20 companies into the country and now there is considerable surveying and drilling in the northern part. Some 20 rigs are in the country.

On the coastal zone, known as Sechura Desert 14 dry holes were drilled. Union Oil (in agreement with Petroleo Sullana, Ltd.) drilled 7; International (Jersey) drilled 5, and Richmond (Standard of California) 2 wildcats.

Cities Service also drilled 4 dry holes on its concessions.

Douglas of California found oil in its 122,000-acre concession at about 2000 ft. Five wells have been drilled. Production is from 3450 ft about 100 b/d per well and must be pumped.

The nine companies holding concessions in East Peru have been carrying out surveying and one Peruvian firm drilled three dry holes. Peruvian Oils & Minerals, a Canadian firm, and Texas Gulf Producing have an exploration program for the Santa Clara structure, near the navigable headwaters of the Amazon. Equipment for drilling will be moved from Texas Gulf's Ganso Azul properties 150 miles south. A Peruvian firm, Cia de Petroleo El Oriente, has drilled three wildcats in the Montana.

International's fields, north of the Sechura Desert, supply about 70 per cent of Peru's total output. Lobitos Oilfields, with a concession still farther north, has most of the remainder. The Ganzo Azul area, in central Peru, produces about 800 b/d, which is processed at the company's refinery there.

International's refinery at Talara has been expanded to 45,000 b/d capacity.

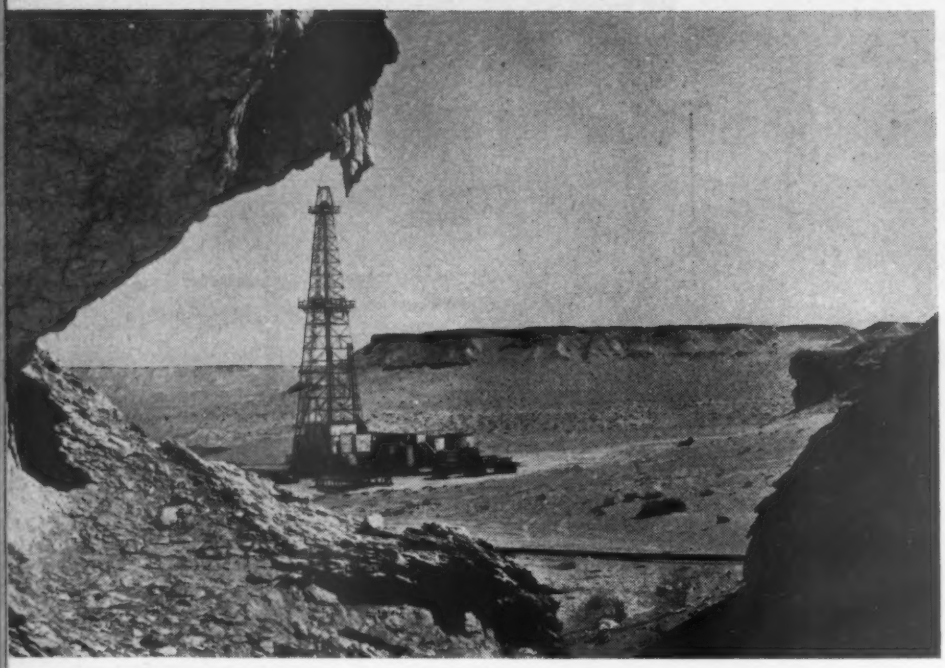
In spite of rising production Peru's demand is going up still faster. In 1953 consumption went up 16 per cent over 1952; in 1954 another 12 per cent increase was estimated. This means that oil for export was only 10,000 b/d in 1954. In 1950 exports were about twice as much.

PHILIPPINES

R. C. 26,000 b/d

Active interest in undertaking oil exploration in the Philippines showed marked increase during the year. Six geological crews conducted surveys, four undertaking ground survey and two aerial reconnaissance.

Luzon Stevedoring Company was granted an exploration concession in northwestern Leyte Island. Exploratory work, consisting of detailed topographic and geologic mapping under a two-year program, was at once started. Caltex (Philippines) Inc. filed an application for



Well in Shogum area, at northeasterly extension of the Ghawar field in eastern Saudi Arabia.

Arabian American Oil Company

non-exclusive exploration permit for the entire island of Luzon. A total of 38 applications for exclusive exploration concession were filed during the year, and those approved for publication in the same period follow:

Applicant	No. of Applications	Acres
Caltex (Philippines)	7	4760
Standard Vacuum Oil Co.	5	4716
Philippine Oil Development Co. (local)	6	4604
San Jose Oil Co., (local and Pantepec and Pancoastal Petroleum)	8	5721

No drilling activity was done during the year.

In addition to geological survey and aerial reconnaissance undertaken by private parties, the Petroleum Division of the Philippine Bureau of Mines conducted geological reconnaissance of southern Palawan Island, and western Davao Province in Mindanao Island. Geological survey will be continued in 1955, and drilling may possibly be undertaken.

The high spot of the year was opening at Caltex refinery in Bauan, Batangas, December 11, 1954. It was the first one in the Republic. The refinery with a capacity of 26,000 b/d, has an average run of 13,000 b/d, using imported crude. It was built by Fluor.

Imports in 1954 were about 34,000 b/d, mostly products.

POLAND

Prod. 4000 b/d R. C. 15,000 b/d (?)

Present production is estimated at about half the objective Communist Poland set. Poland has only the Jaslo fields in the South and part of the Drogobych fields in the Ukraine.

Drilling is reported to have discovered gas but no oil.

PORTUGAL

R. C. 20,000 b/d

Portugal's only refinery has a capacity of 20,000 b/d but a throughput of 12,000 b/d.

Consumption changes little as table shows:

Portugal products imported for consumption.

	In 1953 bbl	Estimated for 1955 bbl
Aviation fuels	351,000	267,000
Motor gasoline	1,182,000	1,151,000
Kerosine	1,024,000	1,041,000
Gasoil	1,224,000	1,268,000
Residuals	1,953,000	2,000,000
Lubes	136,000	123,000
For Re-export		
For bunkers, distillates	992,000	716,000
Residuals	1,007,000	951,000

PUERTO RICO

Caribbean Refining Company began building its 10,000 b/d plant at San Juan in February, 1954. Fluor Corporation is the contractor.

QATAR

Prod. 98,000 b/d R. C. 125,000 b/d

Four new producing wells were drilled, and one rig was operating. The peninsula produced 4.7 million tons from 30 wells in the Iraq Petroleum concession.

A new drilling platform, costing nearly $1½ million, is now in position about 5 miles from shore to test Shell's concession offshore of Qatar.

ROMANIA

Prod. 98,000 b/d R. C. 125,000 b/d

Sovrompetrol, a Soviet-Romanian state company that controls all Romanian operations, has made no report of activities except a political speech in which the petroleum commissar said Romanian crude oil reserves had been doubled in five years. This is doubtful although production has been pushed up. Production is estimated at 2½ times consumption so Romania has enough for export.

A new natural gas line from Ploesti to Bucharest has been completed.

SAKHALIN

Prod. 7000 b/d (?)

No information from here but probably production let down since Korean War.

SAUDI ARABIA

Prod. 953,000 b/d R. C. 189,000 b/d

One structure drill party with 3 rigs operated in the Rub' al Khali the first part of the season. After the summer shutdown period, the party with 2 rigs returned to the same general area. Two structure drill parties operated in the region west of Qaisumah. Seismograph parties were in Central Hasa, Gravel Plains, and in north central Rub' al Khali. Gravity meter parties were in south Rub' al Khali.

Number of drilling strings was increased from 4 to 5 during the second quarter of the year until mid-December when the number of strings was reduced to four. Eight wells were completed, one each at Abqaiq, Ghawar-Huiya Area, and Ghawar-Shedgum Area; two at Ghawar-Hardh Area, and three at Ghawar-'Uthmaniya Area.

Total number of wells completed by the end of 1954 amounted to 254; of this total 144 were producing oil wells.

Oil production for the year 1954 was 347,844,850 barrels, an average of 953,000 b/d and an increase of 108,358 b/d over 1953.

Armaco producing facilities were expanded with a gas injection plant in March, 1954, and the Shedgum gas oil separating plant in May, 1954. The gas injection plant utilizes 150,000,000 cu ft per day of high pressure gas from all three Abqaiq gas oil separating plants. The Shedgum gas oil separating plant was designed for nominal capacity of 100,000 b/d.

Capacity of Aramco pipeline system was expanded from 940,000 b/d to 1,100,000 b/d during 1954 by the addition of a 20-22-in. pipe line 18.3 miles in length and by the modification or expansion of numerous pump stations.

SICILY

Prod. 1500 b/d* R. C. 35,000 b/d

Sicily's first oil field came in in 1953. Gulf Italia Company, a wholly owned Gulf subsidiary (formerly American International Fuel and Petroleum Company), completed two development wells. Ragusa 2 (6670 ft) and Ragusa 3 (7074 ft) as successful step-outs to Ragusa No. 1 in its Ragusa Concession. At year's end a fourth well was drilling at 5196 ft. Production began from this field on December 15 with 19.5 gravity crude being shipped by railroad to the RASIOM refinery at Augusta.

At year's end Gulf Italia was also drilling 2 wells on concessions held jointly with the Macmillan Petroleum Corporation. Comiso No. 1, north of Ragusa, was drilling at 1243 ft, and Aragona No. 1, north of Agrigento, was drilling at 9150 ft.

During the year 12 party months of field geology were completed and 3 party months of seismic work by Gulf Italia.

Compagnia Idrocarburi Della Sicilia D'Arcy S.P.A. (British Petroleum), struck a heavy crude oil in a test well near Vittoria. Further testing will be required before the commercial significance of this find can be assessed.

A natural gas field has been developed by MISO, (ENI, owned by Italian Government) in the Catania Plain, East Sicily. Six wells have been completed.

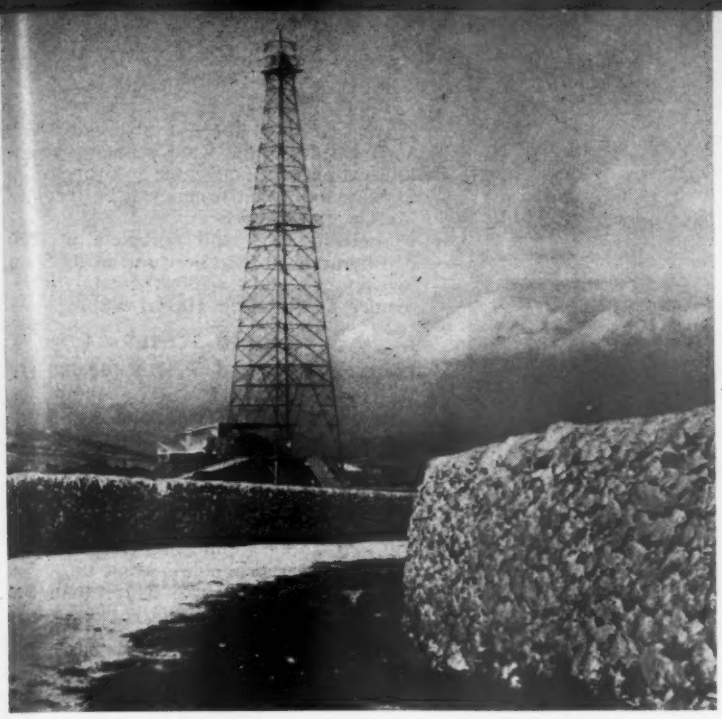
Some half dozen other companies are exploring the island. Sicily has reasonable petroleum laws and has granted more than 30 exploration permits.

*At end of year.

SOMALILAND

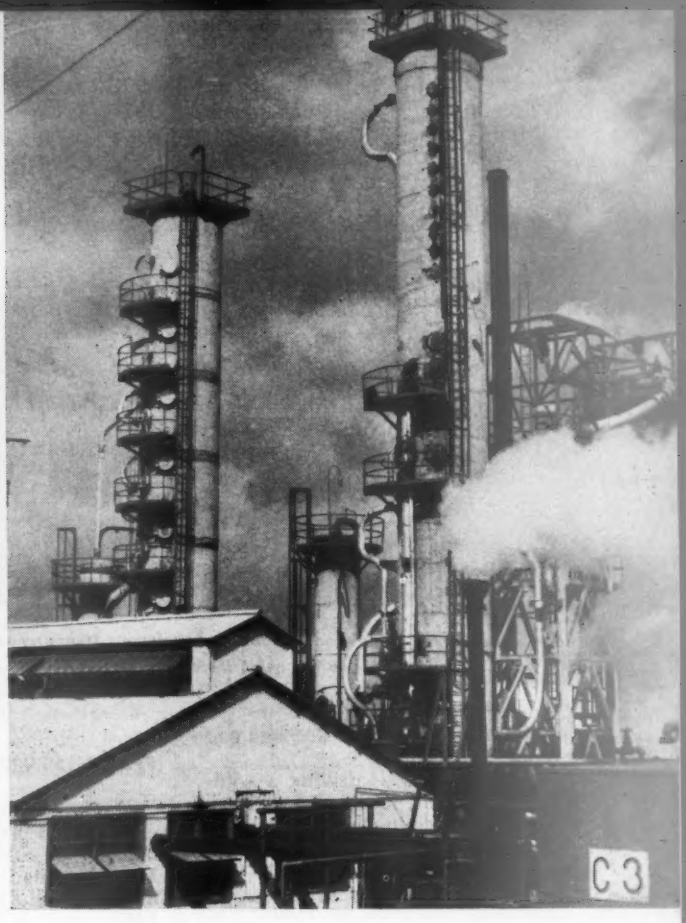
Italian. Sinclair is operating the concession owned by it and Conorado (Conoco, Ohio Oil, Amerada). One geological party and one seismic party are surveying the 77,220 sq mile area.

Mineraria Somala (ENI subsidiary)



American International Fuel & Petroleum photo

Above, drilling at test well near Ragusa, Sicily.



Right, cracking unit at Teneriffe refinery in the Canary Islands.

CEPSA photo

has made a geological survey of its 11,000 sq mile concession.

British. Conorado had 3 geological crews and one magnitometer party in this area to survey a 36,000 sq mile concession.

Standard-Vacuum has acquired some 12,000 sq miles by assignment from Moriqui Exploration Company.

SOUTH AFRICA

R. C. 15,600 b/d

Standard-Vacuum operates the only petroleum refinery, a new one, at Durban. Overland Pipeline Corporation is surveying a route from Durban to Johannesburg (300 miles) with the idea of building a gasoline pipe line.

The oil-from-coal plant of SASOL, (state-owned) at Sasolburg, is under construction. Kellogg International is the contractor. The project is estimated to cost $90 million.

SPAIN

R. C. 104,000 b/d

Several companies hold exploration concessions in Spain and geological work and some drilling are being done without any report of success. Ciepsa and Adaro, two Spanish oil companies, have rigs going in the country. An American firm composed of several Texas companies is surveying a concession near Logrono, and a German firm has joined Ciepsa to explore another section of the country near the French frontier, where the geological conditions are similar to those of the Lacq wells.

Total refining capacity including both the Escombreras and the Teneriffe refineries is 74,000 b/d with runs at present of 50,000 b/d.

The Escombreras (Cartagena) refinery has now a total crude distillation capacity of 44,000 b/d. New facilities for the production of lubricating oils are presently undergoing construction.

Canary Islands. Cepsa's refinery in Teneriffe, Canary Islands (Spain) has a new crude distillation unit of 10,000 b/d on stream since August. A 5000 b/d platforming and 500 b/d Udex unit are being constructed and expected to go on operation in the first quarter of 1955. Refining runs are about 30,000 b/d at present.

SUDAN

British Petroleum is sending a geological reconnaissance party to the Sudan, where no oil exploration work has hitherto been carried out.

SUMATRA (Indonesia)

Prod. 180,000 b/d **R. C. 157,000 b/d**

Shell drilled 2 oil wells in Kahmantan Bunju field and spudded another in 1954. By June the field was producing 2500 b/d. The company had no activities in its Pulu Pandjang field in North Sumatra. Politics in this area is still rough.

Standard-Vacuum plans a 90-mile pipe line from Lirik oil field to a terminal. Sumatra is Standard-Vacuum's main source of crude oil.

SWEDEN

R. C. 34,000 b/d

Consumption in Sweden is third in the world per capita. The U. S. and Canada are the only nations with higher demand.

Two biggest refineries are Koppartrans Olje AB at Gothenburg and AB Nynas-Petroleum at Stockholm. Another refinery is planned.

SWITZERLAND

R. C. 1800 b/d

Two small refineries at Rotkreuz and Dottikon process only domestic products.

TANGANYIKA

In East Africa D'Arcy-Shell Petroleum Development Company of Tanganyika began drilling a deep test well on Mafia Island off the coast of Tanganyika in December. Drilling of the test well follows intensive geological-geophysical surveys since 1951 over wide areas of East Africa. Four geological and two geophysical parties were at work in other East African areas, including Zanzibar, in 1954.

THAILAND

Thai Royal Dept. of Mines engaged Hunting Geophysics, Ltd., to conduct an aerial oil survey of the Bangkok plain.

TRIESTE

R. C. 27,500 b/d

Aquila and Esso have refineries here.

TRINIDAD (British)

Prod. 64,700 b/d **R. C. 120,000 b/d**

Field work was increased some. Three seismic crews were in operation, two active in the north. A gravity survey party also worked in the north three months.

Most important development in 1954 was opening of new 6 to 8-in. 32-mile crude line from Ortoire to Penal. The crude oil then is transmitted to the Point Fortin refinery.

At end of year the 26 rigs operating had drilled 202 wells in 1954 and 185 were producing. The 2728 wells had an output of 64,700 b/d, an increase of 5 per cent over 1953.

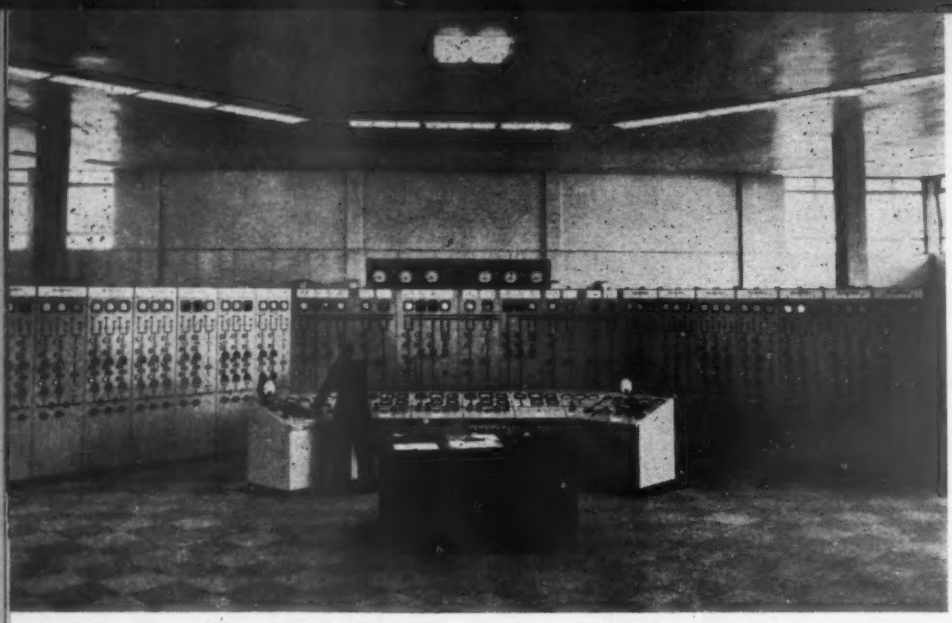
Some 45,672 b/d was imported for processing. Island consumption is only about 4000 b/d or 4 per cent of the total products (100,212 b/d in 1954). The remainder is exported.

TRUCIAL COAST

The well at Murban, in Abu Dhabi—the third well drilled in the Trucial Coast by Iraq Petroleum—was abandoned at a depth of over 12,000 ft.

TUNISIA (French)

Two companies were operating in Tunisia in the fall of 1954. SEREPT (joint French and Tunisian interests) has four rigs, two of which are drilling in Tunisia, one drilling for S.N. REPAL in Algeria.



Interior of power house control room at British Petroleum's Llandarcy refinery in South Wales, where a platformer is being installed. *British Petroleum photo*

not far from the Tunisian border, and one being modernized.

A National 130 rig is drilling a wildcat at Djebel Aksabe, in the Gafour area. An Ideco H 40 is drilling the last exploitation well in the Cap Bon gas field in production since July 15, 1954, upon completion of the 39 miles long 4-in. pipe line connecting this field to Tunis. The shallow gas pool was producing 320 Mcf/d at end of year.

The tests drilled on the Qued Bahloul structure and in Massanerh, near Maktar, have proved insufficient reserves to justify exploitation. Exploration of this area has been stopped after drilling two more holes, one at Souk el Djemaa, near Maktar, and one near Siliana.

In a deep well in Central Tunisia, at Djebel Mansour, near Gafour, gas shows were encountered.

The present trend of SEREPT is towards prospecting the extreme South of Tunisia where four geophysical crews are operating, after aerial photographs were taken.

The CPDT (Shell and SEREPT) carried out exploration of the Sahel with 3 rigs.

SNAP (Gulf and SEREPT) gave up its explorations in the middle of 1954, after drilling five dry holes. This company has sold its National 130 rig to SEREPT.

TURKEY

Prod. 1130 b/d **R. C. 300 b/d**

Turkey passed its new petroleum law prepared with the counsel of the late Max Ball and had immediate requests for exploration permits. The MTA, state oil monopoly, was denationalized and the country opened to private capital.

Nine geological parties were at work, one for MTA and the others for Jersey, Socony, Shell, Caltex, Kern Oil, Cities Service, Deilmann, and Parsons Gas.

MTA, Shell, and Parsons each had geophysical crews at work.

Production at Raman doubled. Six wells were drilled bringing producing wells from 5 to 10. Five rigs are in Turkey.

Ortaklik, owned 51 per cent by the Government and 49 per cent by private interests, is taking over MTA operations. It is constructing a 6250 b/d catalytic refinery at Batman.

Turkey in 1954 consumed about 20,000 b/d about 11 per cent increase over 1953. Most of it is imported.

U.S.S.R.

Prod. 1,150,000 b/d (?) **R. C. 1,000,000 b/d (?)**

Crude oil production for the first half of 1954 was proclaimed to be 10 per cent higher than for the same period in 1953. Malenkov had announced a 1953 production of 1,050,000 b/d in August of 1953.

From hints dropped in the Soviet press, the Oil Commission was critized for having too much personnel and too great expense. According to Albert Parry, Colgate University, this is not limited to the oil industry. He compared many industries. One example was two powerhouses, each producing the same amount of electricity; one in New Jersey had 51 employees, the other in Siberia had 480, a very high percentage of them bosses.

About 90,000 b/d crude oil is being bartered in many parts of the world. About half went to Sweden, Finland, Iceland and Norway and most of the remainder to Argentina, France, and Italy. Oil is by far Russia's most important export to the West.

Natural gas production was reported to be 12 per cent above 1953. Largest reserves are near Saratov, from where a pipe line runs to Moscow to supply that city. Second in importance are those taken from Poland in Western Ukraine after World War II. Although no figures are released, it is known that the goal for 1955 was about 25 per cent less than the goal set for 1950, so obviously the 1950 goal was not reached.

Refining is thought to be inefficient generally with a good proportion of obsolete plants. This is purely guesswork.

UNITED KINGDOM

Prod. 1130 b/d **R. C. 600,000 b/d**

Crude oil production was 413,000 bbl (estimated) mainly from the established Eakring (Nottinghamshire) oilfields. At the Plungar field, also in Nottingham, 6 production wells were drilled. Of 15 wells drilled in 1954, 5 were producing. The total number of wells producing in the U.K. is 222.

British Petroleum's U.K. refinery thoughput was 211,000 b/d. At Grangemouth, (Scotland) a catalytic polymerization plant came into operation; at Llandarcy (South Wales) a platformer will be commissioned in spring 1955, and at about the same time the new $1,650,000 jetty at Swansea for coastal tankers, will be finished. At the Kent refinery, a new lubricating oil plant came into operation in May and a platformer will be ready in March, 1955.

Shell in 1955 will complete a 5200 b/d hydrodesulfurization unit at its Stanlow refinery and a 6700 b/d catalytic reformer at the Shell Haven plant.

UNITED STATES

Prod. 6,350,000 b/d **R. C. 8,400,000 b/d**

Although demand was up about one per cent over 1953, production was down about two per cent, the margin being filled with imports. Imports were 1,065,000 b/d, slightly more than in 1953.

Consumption ran about 8,100,000 b/d in 1954. Refinery throughput was 6,955,000 b/d, about 45,000 b/d under 1953.

Natural gas production went up about 5 per cent above 1953. More than 8.8 trillion cubic feet were marketed.

This is a glimpse of the U.S. petroleum industry—amounting to more than half the world's operations.

URUGUAY

R. C. 27,000 b/d

ANCAP, State oil firm, owns the only refinery and distributes products from it. This covers the nation's demands.

VENEZUELA

Prod. 1,895,300 b/d **R. C. 523,970 b/d**

At the end of 1954 there were 9 geological and 15 geophysical parties working in Venezuela. The approximate 127 rigs operating drilled 836 wells in 1954, of which 693 were producers. Total wells producing were 9215 on December 31, 1954.

Oil production in Venezuela by companies.
(Barrels per day)

Companies	November 1954	December 1954	Average for year
Creole	938,033	962,521	823,710
Shell	543,425	567,572	564,141
M. G. O.	301,825	310,650	292,207
Socony	69,679	76,692	66,148
Texas	41,637	44,252	30,723
Mercedes	26,552	25,710	24,823
Atlantic	20,778	21,448	20,656
Richmond	32,262	30,743	34,432
Sinclair	23,742	24,868	20,188
Phillips	8,214	7,788	8,315
Pantepec	7,527	8,973	8,095
Talon	1,307	1,548	1,238
Coro	293	443	484
Caracas	117	128	149
Total	2,015,391	2,083,336	1,895,309

Venezuela has oil reserves estimated at 11 billion and gas reserves of about 26 trillion cu ft.

Refinery runs in 1954 averaged 443,400 b/d. No new plants are under construction but a fluid hydroformation unit of 10,000 b/d capacity is being added to Creole's Amuay refinery.

Shell plans a new 35,000 b/d cat cracker at its Cardon refinery.

See Page E-8 for Part 2 of a full review of Venezuelan oil.

YUGOSLAVIA

Prod. 4500 b/d **R. C. 12,000 b/d**

The figures given are estimated on reports of the first half of 1954. Yugoslavia's operations are being expanded in hopes of balancing demand. Annual imports of crude oil and products run more than 11,000 b/d.

UHDE, State monopoly, is expanding its Sisak refinery.

ZANZIBAR

D'Arcy-Shell exploration parties working here.

* * *

Exploration, Drilling, Producing

Production for Canadian

Canada's largest all-Canadian oil company is organizing a production department, with headquarters in Calgary, Canada. Primarily a marketing and refining company, Canadian Oil Companies, Limited, is the last of the large Canadian companies to enter this phase of the oil industry.

★ ★ ★

Signal Grant

Stanford School of Engineering has received a $10,000 grant from Signal Oil and Gas Company for special study of peacetime nuclear energy and its relation to the oil industry, the school recently announced.

★ ★ ★

Field Conference

Four Corners Geological Society is opening its doors this year to include geologists and students for its first field conference June 15-17. The society's guests will move through the San Juan and Paradox Basins in Colorado, New Mexico, Utah, and Black Mesa areas in Arizona in glass-topped sight seeing busses.

★ ★ ★

Texas Tech Course

Texas Technological College's petroleum engineering department is expecting over 500 at its annual West Texas Short Course on Oil Lifting Methods meeting at Lubbock April 21-22. More than 30 papers will be presented at the course.

★ ★ ★

Big Chief Sells Production

Big Chief Drilling Company, Oklahoma City, Oklahoma, has sold its production and leases in West Texas to the General American Oil Company, Dallas, Texas. Involved in the sale were 85 producing wells, with reserves estimated at 1,500,000 bbl of oil.

★ ★ ★

"Safety and the Driller"

American Association of Drilling Contractors has announced a new 61-page booklet, "Safety and the Driller" emphasizing the importance of the driller and his responsibility to his crew and the rig owner, as regards to safety.

★ ★ ★

Income Tax Rulings

The Internal Revenue Service ruled in March that partnership in a drilling contracting firm has no relationship to the oil and gas production activities of the taxpayer, individually (55-121). In ruling 55-118, the service held that rentals paid or accrued on non-producing oil and gas leases may be capitalized as carrying charges on unimproved or unproductive real property without regard to how such charges were filed in previous years for the same lease.

★ ★ ★

Indians Get Lease Money

More than 5000 members of the Blackfeet tribe of Montana are dividing $340,000 of funds resulting from oil and gas lease dividends.

★ ★ ★

Louisiana Order

Louisiana conservation department has released an order requiring that before any well is perforated, drilling fluid shall be brought to a weight necessary to hold normal hydrostatic pressure with margin of safety.

★ ★ ★

Cease-Flare Order

On recommendation of various producers in the Clareton field area, the Wyoming oil and gas commission issued an order shutting down oil wells producing more than 5000 cu ft of natural gas per barrel of oil. It is hoped that conservation of the 30,000,000 to 50,000,000 cu ft of gas flared daily will hasten construction of a natural gas plant near Newcastle, Wyoming.

Jamaica Gets Wildcat

Base Metals Mining Corporation, Ltd., of Canada has announced that drilling has begun on the first oil well in Jamaica. The corporation has sole prospecting rights in Jamaica and territorial waters, although United States oil companys are negotiating for exploration rights in surrounding islands. Reports are that the Texas Company may get rights to nearby Turks Islands.

★ ★ ★

Lion Comes to Liberal

Production and exploration division of Lion Oil Company has established a new district in Liberal, Kansas, handling activities in parts of southeast Colorado, the Oklahoma Panhandle and the southwestern part of Kansas. Jack V. Newman and Glenn F. Thomas will head the office.

★ ★ ★

Pressure Problems

Agitation for API standards for well-head end connections designed for working pressures up to 15,000 psi was encouraged by C. H. Taylor, Shell Oil, before American Petroleum Institute's production meeting in New Orleans, Louisiana. The industry is required to contain extremely high pressures found in Gulf Coast deep wells with growing frequency.

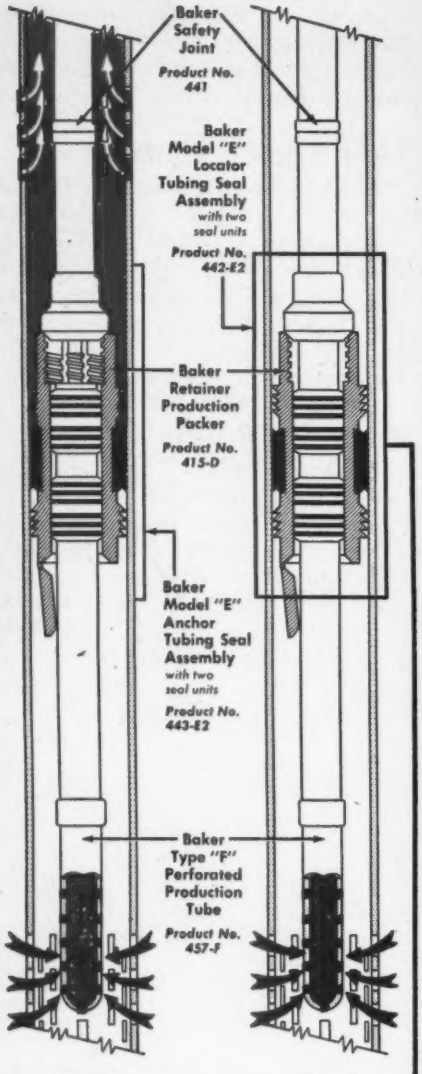
First oil well drilled in the Province of Alberta, Canada. It was drilled in 1902 at Waterton Lakes.

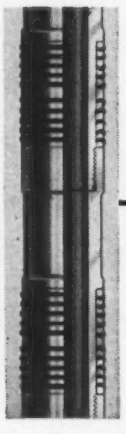
Single Zone

Dual Zone PRODUCTION

WITH 1 BAKER

RETAINER PRODUCTION PACKER


Baker Safety Joint
Product No. 441
Baker Model "E" Locator Tubing Seal Assembly with two seal units
Product No. 442-E2
Baker Retainer Production Packer
Product No. 415-D
Baker Model "E" Anchor Tubing Seal Assembly with two seal units
Product No. 443-E2
Baker Type "F" Perforated Production Tube
Product No. 457-F
TYPICAL DUAL ZONE HOOKUP
TYPICAL SINGLE ZONE HOOKUP



Right: Picture shows actual detail of seal units

Do you know that with only ONE Baker Retainer Production Packer you can equip your well for *either* SINGLE ZONE or DUAL ZONE production? And that you can accomplish *any* type of completion for *any* method of production to meet *fixed* or *changing* well conditions?

A single Baker Retainer Production Packer will also outperform many specialized tools when used as a TESTING PACKER – SQUEEZE PACKER – GAS LIFT PACKER – PERMANENT COMPLETION PACKER – WATER FLOOD PACKER – GAS INJECTION PACKER – CORROSION CONTROL PACKER – TUBING ANCHOR – ONE-WAY BRIDGE PLUG – PERMANENT BRIDGE PLUG.

Every production man should be familiar with the many operating advantages of this "Universal Type" Packer, which include . . .

WIRE LINE SETTING—The packer can be set with *wire line speed and accuracy,* using the same set-up just used for perforating. The Baker Packer also can be set on drill pipe or tubing.

SETTING UNDER HIGH PRESSURE—By using a lubricator, the Baker Retainer Production Packer can be set under high pressure. From the moment it is set, the self-contained, flapper-type, back-pressure valve closes and isolates pressure below the packer.

TUBING STRING IS ALWAYS "FREE"—That valuable string of tubing—whether 1,000 feet or 16,000 feet in length—can be removed by simply picking up the tubing weight.

EXCESSIVE "SET-DOWN" WEIGHT OR TENSION NOT REQUIRED—Even when squeezing, formation fracturing, or producing at any depth under pressure, a perfect pack-off is maintained independent of excessive set-down weight, or tension.

HOLDS PRESSURE DIFFERENTIALS FROM ABOVE OR BELOW—Two sets of opposed slips, and a resilient packing confined by lead and metallic sealing rings, effect a permanent pack-off that will hold any pressure differential *either from above or below the packer* that is safe for the well equipment.

GOOD PUBLIC RELATIONS

Should Begin With

The Drilling Contractor

Gene Graham

"THE drilling contractor is the first contact that the public has with the operators, and consequently the first opportunity to establish good public relations for the industry. It is, therefore, his responsibility to preserve goodwill and assure public acceptance of his activities." So S. M. Bowlby, vice president of Shell Oil Company, in charge of public relations, told those who attended the recent AAODC convention in Los Angeles.

The truth of this statement is obvious. There is some doubt, however, as to whether the average drilling contractor takes full advantage of this opportunity to make it easier for his company, the producers and others, to operate near centers of population, or takes definite steps to head off squawks against the industry that may result from disturbances ranging from dangerous accidents and fires down to mere noise.

A Typical Case

Take a typical case which happened a few years ago in a California city. The contractor was drilling in several directions from an island in a rather densely populated section of the city for tests under residential property. A boiler explosion wrecked the rig and hurled the boiler 600 ft through the air laterally. Fortunately there were no fatalities and no property damage except that of the contractor.

So what? There was an immediate uprising among the surrounding residents, particularly the women, demanding that the city outlaw drilling in the whole community. One woman, a leader in the local P-TA spearheaded the attack, although a good part of the employment and city taxes were derived from petroleum industry installations in the immediate neighborhood. In the face of such public indignation it would have been useless to look for help from the city authorities, and any attempt to ignore it might have made the operators a target for all kinds of legal action, regardless of the contractor's responsibility. Obviously, something positive and constructive had to be done. But what?

Remedial Public Relations

In this particular case, quick action was taken to contact the newspaper editors and explain the facts of the case, showing that the accident was not due to negligence and that it might have happened anywhere. The editors were not only cooperative but grateful for the true facts of the case and the newspaper stories were toned down to a factual reporting level as a result.

On consulting the public relations counsel it was apparent that the problem of the local residents was something that had to be handled at the source, rather than making a general public appeal for tolerance. The advice was to approach the women who were spearheading the public outcry against local petroleum company activities and turn a source of opposition into a medium of understanding. A culprit or an enemy always seems surprisingly human and harmless on close acquaintance, and mutual understanding and community interests can take the strife out of almost any difference of opinion.

The leaders of the P-TA and other protesting groups were called upon personally and the facts of the whole case laid before them, with offers to have a representative address a meeting.

No attempt was made to minimize the fact that a dangerous accident had

EXCLUSIVE

occurred, other than the fact that such things happened everywhere that heavy industry was present. Stress was laid upon the fact that it was regular procedure in the petroleum industry to take every precaution for the safety of the workmen, the neighboring residents, and property. Explanations of drilling techniques were given, showing that oilwell drilling was a highly scientific process, and that hazards to surrounding property are far below those of airports, transportation companies, and other necessary lines of industry. Positive stress was then laid upon the benefits accruing to the whole community through the creation of employment, the contributions to the tax program, and other effects of the industry being part of the community.

The net result was that the hue and cry quickly died down and business went on as usual. This particular operator is still developing and administering properties in the area and public relations are good.

Getting Credit for Good Intentions

Besides explosions and fires, there are other standard objections to oilwell drilling in congested areas, such as noise, unsightly rigs and drillsites, and fumes, many of which can be minimized if not eliminated. If efforts are made to render these dangers and annoyances less objectionable, they offer a wonderful opportunity through publicity to build goodwill, public acceptance of the industry's local activities, and finally to head off local ordinances which would forbid all drilling activities.

Failure to sell the public on the benefits of such activities to the community have recently resulted in ordinances which prohibit drilling in one of the cities of Los Angeles County, California, which stands over known oil reserves. A good preventive job of public relations might well have made it possible to have had the city council's decision the other way, and the public's acceptance of a development program.

This matter has had little attention among contractors until now, but its value is apparently becoming known to enlightened managers. As an example, the Water Department of a medium-sized California city recently had occasion to do some work in an adjoining town. For several blocks on either side of the street where the work was to be done a mimeographed letter was distributed by hand, warning the residents that traffic might be somewhat interrupted, and asking that the public be patient with whatever inconveniences this activity might cause temporarily. The earlier methods of some public utilities were not so well thought out, and they certainly paid no dividends that had to do with public goodwill.

Among the common objections to oilwell drilling in populous areas, noise stands high on the list. Shielded rigs can reduce this annoyance considerably, but the point to be emphasized is, that if measures are taken in the public interest to minimize the annoyance, the gesture should be brought to the attention of the local inhabitants through publicity stories in the local newspapers. They should point out the efforts being made by the contractor or the operator to serve the public interest. The local editors are almost always glad to cooperate in bringing such information to the attention of the public.

By the same process, a story about rigs which are treated to make them blend into the landscape can also be used as a theme for molding favorable public opinion. All of this activity costs no more than the time and the effort to bring the facts to the attention of the public. Newspaper space does not have to be bought. It pays handsomely in the long run as preventive medicine against public illwill in the event of even a minor catastrophe or an accident. It also helps to establish the operators as local business enterprisers who are part of the community and, therefore, entitled to fair consideration.

The Author

Gene Graham is vice president and general manager for Thomas P. Pike Drilling Company. He was graduated from Californinia Institute of Technology and joined Baker Oil Tool Company in 1935. Six years later he became a plant manager for the Grant Tool Company, and in 1948 became assistant to the president of the Rocky Mountain Drilling Company. He accepted his present position in 1951.

Internal Medicine for the Drilling Contractor

If we accept the fact that a public relations program for preventive and remedial measures such as the above are good business for the drilling contractor and the operators, the fact immediately presents itself that concrete results must rest on a program of internal medicine which will sell the field personnel of the contractor's firm on the necessity and the utility of good public relations. It should be the work of the foreman and the drillers and even of crewmen to create and maintain the feeling locally that their employer's firm is an asset to the community and is taking every responsible means to function there for the benefit of all. If this by any chance is not true, then in the interest of good business, steps should be taken to make it true. Nothing is to be gained by taking an aloof attitude toward local residents or even the merchants. A leaf might well be taken from the far-sighted policies of major producers who virtually join the communities in which they locate and make it a point to bring wealth to the area and keep a reasonable amount of it there.

The drilling contractor's stay is likely to be fleeting, but while he is in a given area, as Mr. Bowlby pointed out, he is *the petroleum business* temporarily, as far as the public is concerned, and as such it is his duty to the operators to establish good public relations with the inhabitants of the area and leave a pleasant aftermath of his attitude and activities.

Enlist the Aid of the Personnel

In our organization which operates under a plan of incentive management with profit sharing, the entire personnel is given an opportunity to share in the management of the firm as well as the profits. At advisory board meetings, which representatives from all levels of employment attend, it is now a company policy not only to ask for cooperation in promoting good public relations in every community where we operate, but also to stress continually the fact that such activity is good for the business in which they have a stake.

From the standpoint of sales, responsibility is just as much a factor in bidding for a contract as the price, perhaps more so; and a reputation for guarding the goodwill of the industry is a tangible and valuable factor in a line of business which spends millions yearly to maintain favorable relations with the public at large.

As Mr. Bowlby pointed out, the drilling contractor is the first contact that the operator has with the public in a given area. For that reason he has a direct obligation to safeguard the goodwill of the operator until he takes over at completion. Failure to do so could be bad for relations between the operator and the contractor if trouble develops later. In any case, the public has a right to consideration and, aside from making the business a welcome enterprise in the region, maintaining friendly relations with everyone possible is something for good citizens to work for as a sound business policy.

* * *

Barrel-plunger clearance determines slippage, lubrication, and friction losses in rod pumps and influence volumetric efficiency

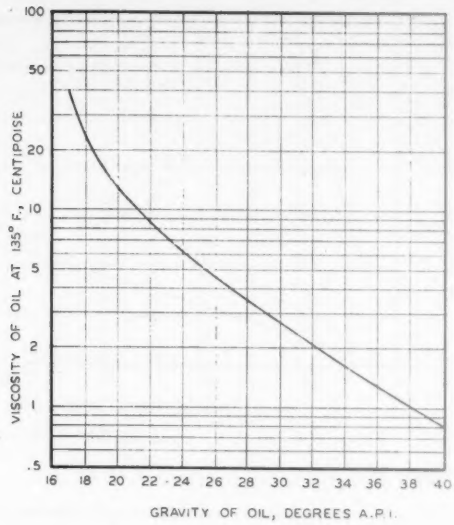


FIG. 1.

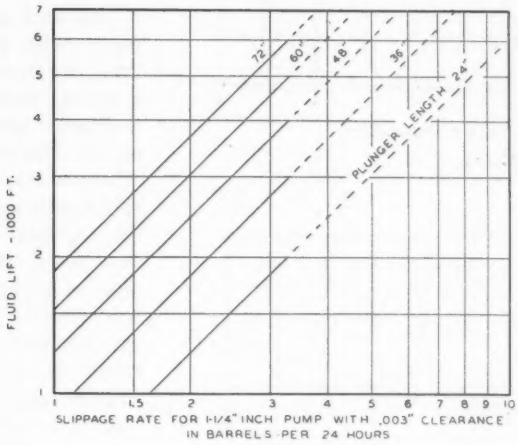
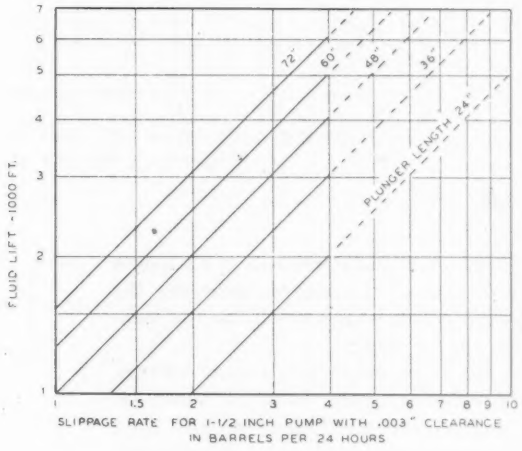


FIG. 2.

FIG. 3.

PLUNGER FIT *Sets* Pump Performance



Kenneth N. Mills

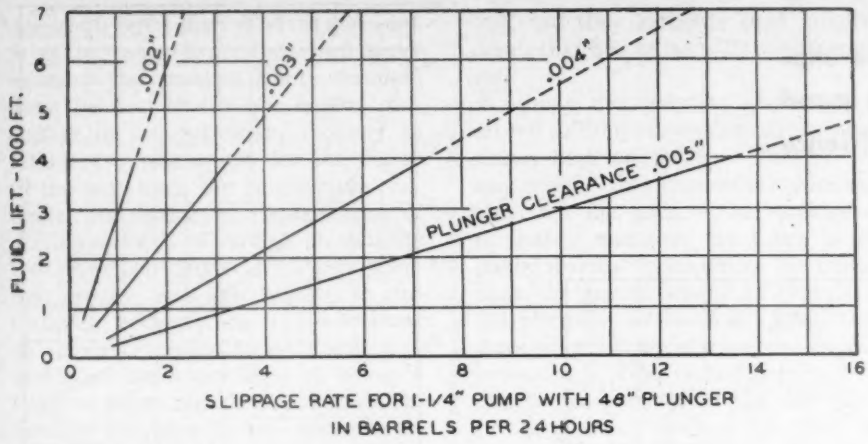
PERFORMANCE characteristics of metal to metal sucker rod pumps are influenced by the fit of the plunger in the barrel. The magnitude of this clearance determines the rate of fluid slippage past the plunger, the amount of fluid available for plunger lubrication, the size of the sand particles that will enter the space between the plunger and barrel and the degree of freedom of action of the plunger in the barrel.

The most apparent influence is its control over the rate of fluid slippage, which influences the volumetric efficiency of the pump. This loss may not be an important consideration in determining the overall efficiency of the pump, because it is influenced by several other factors.

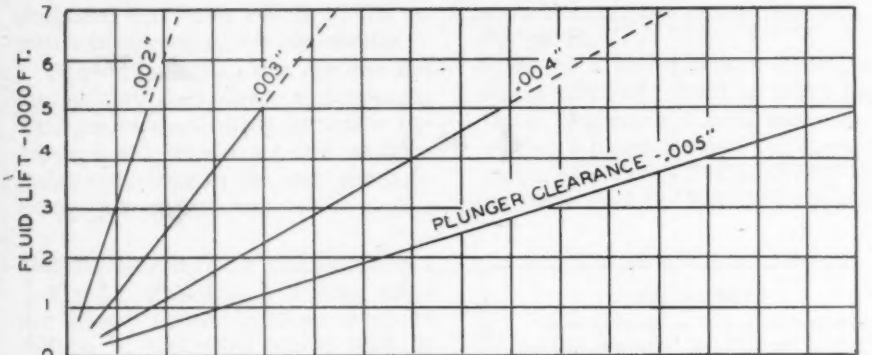
Some of these factors are free gas entering the pump, foamy or frothy fluid, underfilling due to fluid friction in the pump's suction system, erratic valve action, and excessive plunger friction reducing the effective plunger travel.

The rate of fluid slippage past the plunger is controlled by the clearance between the plunger and barrel, length of plunger and viscosity of the well fluid. Assuming a given fluid viscosity, the principal factor controlling leakage is plunger clearance, because the leakage rate increases with the 3.33 power of the clearance. For example, changing the clearance from .001 to .003 in. will increase the leakage rate approximately 860 per cent.

Naturally, the importance of this increase will depend on the value of the leakage rate as related to pump displacement, and it does not become important until it results in a material decrease in efficiency. *Considering a constant clearance, the rate of slippage is directly proportional to the length of*



▲ FIG. 4.



▲ FIG. 5

the plunger and decreases as its length is increased. Therefore, doubling the length of the plunger will cut the leakage rate in half.

The other important factor controlling leakage rate is fluid viscosity. *Breakage varies indirectly with the fluid viscosity and decreases as the viscosity increases.* The viscosity of petroleums are dependent on their chemical composition and temperature. Their viscosity will range from approximately 0.5 to over 100 centipoises at bottom hole temperature. In some extreme cases it may approach 1000 centipoises. The viscosity of water is one centipoise at 68 F.

The relationship between API gravity and viscosity for oils produced from the Elk Hills field of California is shown in Fig. 1. This chart is based on data compiled by the Bureau of Mines.[1] As the viscosity of the fluid is influenced by several variables, the relative values of API gravity and viscosity shown in Fig. 1 are not applicable to other crude oils. The general relationship indicating that viscosity increases as the API gravity decreases, however, is true for all crude oils.

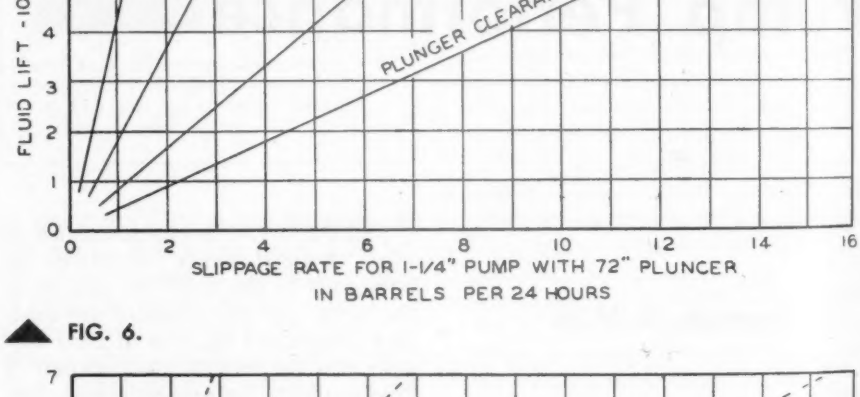
When the fit of the plunger is correctly chosen, the velocity of the fluids slipping past the plunger is usually low. If it is in the range of streamline flow, grooves in the plunger will not materially effect the rate of leakage.

If the fluid velocity produces turbulent flow, grooves will create additional turbulence and cause a slight reduction in the rate of slippage. The principal function of grooves is to facilitate plunger lubrication by providing oil reservoirs.

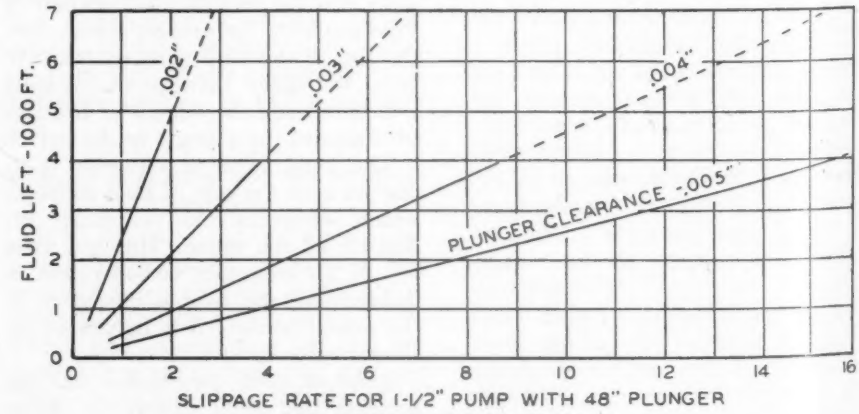
The fact that slippage increases directly with pressure (height of fluid lift) and inversely with plunger length is recognized in practice by providing a definite length of seal for each foot of lift. The usual practice is to provide 12 in. of seal per 1000 ft of depth. This seal length should be increased if paraffin deposits occur in the tubing and flow lines to compensate for the increased pressures resulting from these restrictions. To assure adequate plunger lubrication, the maximum plunger length is commonly set at 6 ft.

The relationship between slippage rate and depth for various lengths of 1¼-in. bore pumps is shown in Fig. 4, 5 and 6. The same information for 1½-in. bore pumps is shown in Fig. 7, 8, and 9.

These charts are based on producing a fluid with a viscosity of 1 centipoise, which corresponds to water at 68 F.



▲ FIG. 6.



▲ FIG. 7.

The actual slippage rates, when producing water from a well, will usually be higher due to its being at a greater temperature.

As the viscosities of most oils are higher than unity, these slippage rates are higher than those found in most wells producing oil. For example, if the viscosity of the well fluid were 10, the slippage rate would be one-tenth of that shown on the charts.

From this data it is apparent that the slippage rates with small amounts of clearance and properly chosen plunger lengths are rather low, but can reach important proportions when the plunger clearance becomes excessive.

Plunger clearance becomes increasingly important as pump bore size is decreased, because the pump displacement decreases as the square of the bore diameter and leakage with the first power of the diameter. Consequently, the percentage of the displacement lost as slippage increases as the bore diameter is decreased.

This becomes especially important in 1 and 1-1/16-in. bore diameter pumps operating at low speeds. Naturally, the limiting value of clearance will be influenced by fluid viscosity, because it determines the leakage rate.

The effect of increasing the plunger clearance on the efficiency of a 1½-in. bore pump producing a one centipoise fluid is shown in Table 1. From this table it is apparent that large values of clearance can cause material losses in pump effiiciency when producing fluids with low viscosities. Naturally, the pump efficiency will be proportionally higher than that shown in the table, if the viscosity of the fluid is greater than unity.

In addition to controlling the rate of fluid slippage the fit between the plunger and barrel determines the size of sand particles which can enter this space. Consequently, the magnitude of the clearance could influence the ability of the pump to produce abrasive fluids.

If the clearance were sufficiently small to exclude all sand particles, they could not enter and cause plunger and barrel wear. The feasibility of this practice can be evaluated by making size clasisfication studies of oil well sands.

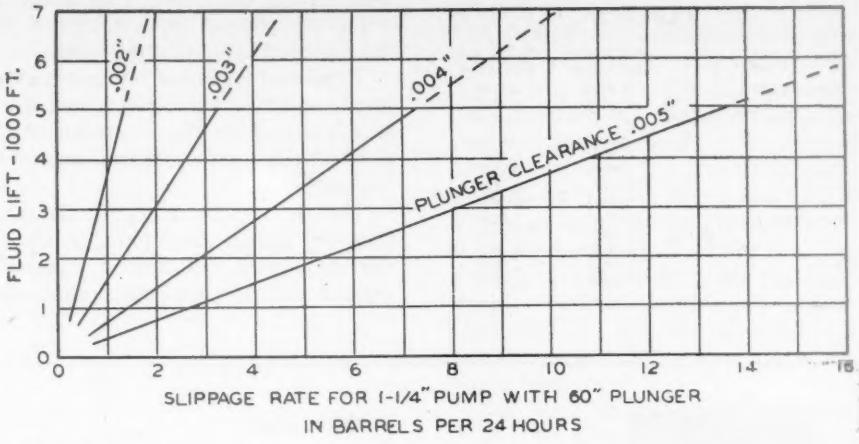


FIG. 8.

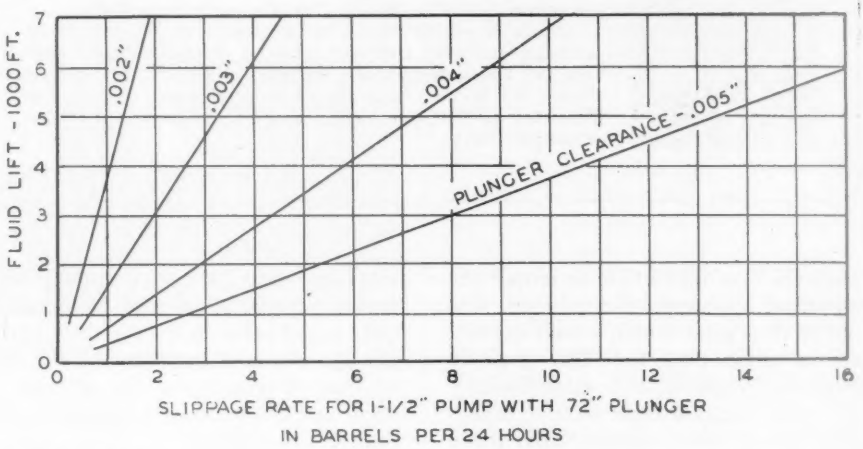


FIG. 9.

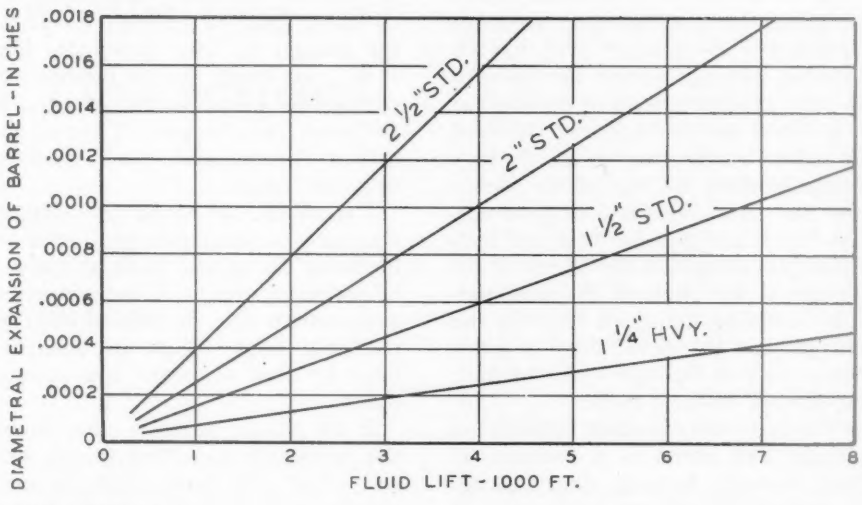


FIG. 10.

TABLE 1. 1½-in. bore pump lifting water from any depth with plunger length equal to 12-in. per 1000 ft of lift.

Pump stroke and speed	Pump displacement bbl/24 hr	Slippage as a percentage of displacement for plunger clearance as shown				
		.002	.003	.004	.005	.006
54" 20 SPM	283	0.58	1.39	3.12	5.75	9.68
54" 15 SPM	212	0.77	1.86	4.16	7.68	12.9
54" 10 SPM	141	1.16	2.79	6.26	11.5	19.4
44" 20 SPM	230	0.71	1.71	3.84	7.08	11.9
44" 15 SPM	173	0.94	2.28	5.21	9.42	15.9
44" 10 SPM	115	1.42	3.42	7.68	14.2	23.8
34" 20 SPM	178	0.92	2.21	4.96	9.16	15.4
34" 15 SPM	133	1.23	2.96	6.65	12.3	20.6
34" 10 SPM	89	1.83	4.42	9.93	18.3	30.8

In the discussion of a paper by Coberly,[2] Stanley Gill presented the sand particle classification data shown in Table 2.

This classification data shows per cent of the total sand sample which was retained on a screen with openings of the size shown. Considering the 90 per cent column, 10 per cent by weight of the sand particles in the sample were smaller than the sizes shown.

In view of the small size of these

TABLE 2.

Field	40 Per cent size, inches	90 Per cent size, inches
Corpus Christi	0.0108	0.0083
	0.0066	0.0017
Barbers Hill	0.008	0.0029
Manvel	0.0105	0.0029
Damon	0.0062	0.0023
Louisiana	0.0064	0.0037
Humble	0.0105	0.0043
Pierce-Junction	0.0062	0.0019
Seven Sisters	0.0066	0.0044
	0.0063	0.0041
	0.0076	0.0023
Moore	0.0052	0.0034
Goose Creek	0.0094	0.0029

particles it is impractical to reduce the clearance between the plunger and barrel to a value which would exclude all of these particles. This practice might be practical with some California sands because their minimum particle size is much greater than those found in Gulf Coast unconsolidated sands.

As all of the sand particles cannot be prevented from entering the space between the plunger and barrel, grooved plungers should not be used in wells producing sand. If the plunger is grooved, the sand particles will tend to collect in the grooves and form a bridge between the base of the groove and the barrel. This will cause excessive barrel and plunger wear and may freeze the plunger in the barrel. If the plunger is not grooved, the sand particles entering the space between the plunger and barrel will have a better chance to pass through without inflicting damage on these parts.

The minimum clearance between the plunger and barrel is a function of fluid viscosity, because some leakage is essential for plunger lubrication. If the pump is not fitted with this clearance, wear will provide the clearance. This is undesirable, because the resulting surface has poor wear-resisting characteristics.

When sliding surfaces become mated through the normal wearing-in process, they develop a smooth work-hardened surface that is resistant to galling. If they wear in through abnormal processes, such as insufficient lubrication, resulting surfaces are rough as they are produced by highly localized galling, and they may never develop the smooth work-hardened surface produced by normal wear.

A general value for minimum clearance cannot be established, because it is dependent on the accuracy of the parts, their surface finish and fluid viscosity.

The minimum plunger clearance that will permit good plunger lubrication in a well that flows by heads is greater than the minimum permissible clearance in a normal pumping well. When the well is flowing, the pressure differential between the two ends of the plunger is zero. Consequently, the rate of fluid slippage past the plunger is zero, and this fluid is not available for plunger lubrication.

Under these conditions the plunger must depend on the oil's adhering to the barrel for lubrication, and the clearance must be sufficient to permit the plunger to "ride over" this film. If it is too small, this oil film may be scraped off ahead of the plunger. In this event the plunger will not receive sufficient lubrication, and excessive wear will occur.

Experience has shown that plunger friction is a predominating factor influencing the volume of fluid that can be produced from wells being pumped at maximum rates. In wells of this type relatively large values of clearance must be used to assure free plunger travel.

If the plunger fit is too close, excessive friction forces will be created. This will subject the sucker rods to compressive force that will cause the sucker rods to buckle. The buckling of the rods will reduce the plunger travel and, therefore, the pump displacement. It will also subject the sucker roads to adverse loads which will cause premature rod failures.

When the pump is fitted with a relatively loose plunger, the efficiency loss resulting from the higher slippage is more than compensated for by increased plunger travel.

The principal effect of high bottom hole temperature is to decrease the leakage rate. As both the plunger and pump barrel are immersed in the same fluid, it is reasonable to expect them to have approximately the same temperature. The practice, therefore, of employing looser fits in pumps that are applied to high bottom hole temperature wells is in error. The fallacy of this practice is further illustrated by comparison of the co-efficients of expansion of steel and alloy cast iron.

The co-efficient of expansion steel is 11.7 by 10^{-6} in. per inch per degree Centigrade, and that for alloy cast iron is 10.5 by 10^{-6}. If the barrel is made of steel and the plunger is of the composite construction with alloy cast iron sections, increasing the temperature of the pump will increase the clearance between the plunger and the barrel. If the temperature change were 100 F, this increase in clearance would be only one-tenth of a thousandth of an inch in 1½-in. bore pump, which is insignificant. If the pump had a liner barrel with cast iron liners, the clearance would be decreased by a like amount.

The normal operating cycle of a pump subjects its barrel to high differential pressures which either tend to increase or decrease the clearance between plunger and barrel. If the pump has a bottom hold-down, the differential pressure tends to reduce the clearance. The magnitude of this effect is shown graphically in Fig. 10.

The tubes designated as standard have ⅛-in. thick wall which is commonly found on the heavy wall barrel pumps. In general, the maximum practical depth for each bore pump is limited by rod and tubing stretch.

When these limits are considered, it is apparent that the maximum increase or decrease in clearance resulting from differential pressure is approximately .001-in. This effect is not worthy of consideration in the average installation, because its magnitude will be materially less than this maximum value.

As the optimum value of plunger clearance is dependent on both the viscosity of the fluid and the performance characteristics of the well, a definite value for the most desirable fit cannot be established.

If the pump is not fitted with sufficient clearance for the prevailing well conditions, it will wear at a rapid rate until the required clearance is established. Reasonable values of clearance which permit sufficient leakage for effective lubrication will not adversely effect the efficiency of the pump, and will probably extend its life.

The Author

Kenneth N. Mills is a practicing oil consultant in Tulsa, Oklahoma. He began his career with American Manufacturing Company following graduation from Rice Institute in 1933. In 1940 he joined Bethlehem Supply Company as chief engineer.

During the war he became works manager for Texasteel Manufacturing Company and later assistant chief mechanical engineer of Emsco Derrick and Equipment Company of Houston, Texas. He joined Ideco as machinery products manager at Columbus in 1949, and later became chief engineer with Walter O'Bannon, Tulsa.

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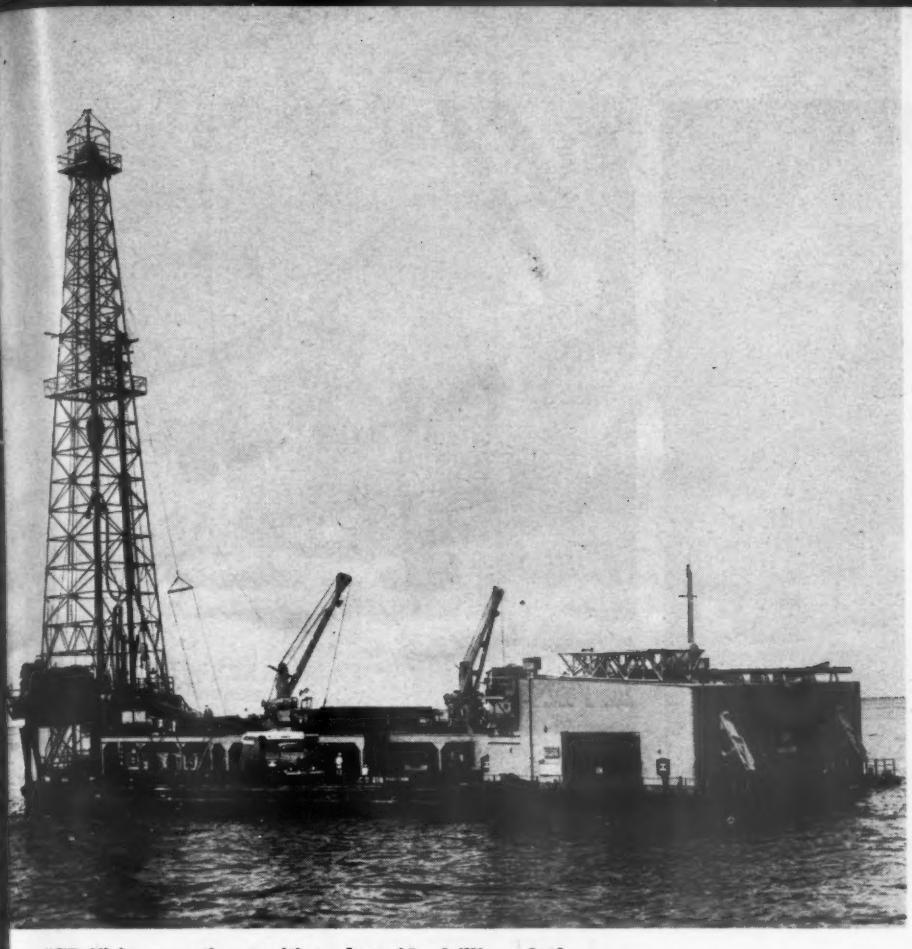
2. "Selection of Screen Openings for Unconsolidated Sands," by J. C. Coberly, API Drilling and Production Practice, 1937.



"GP-2" in operating position alongside drilling platform.

DRILLING BARGE Designed for Lake Maracaibo Operations

Vessel serves as tender in association with deep-water platform-mounted equipment in South American development operation

THE diesel electric drilling barge "GP-2" of the Compania Shell de Venezuela Ltd. was designed for drilling on Lake Maracaibo. Delivery of this vessel from Britain and its introduction into lake operations marked the consummation of joint efforts of engineers in Europe, United States, and Venezuela over a period of several years. The essential features of design, as laid down at the outset, called for a vessel capable of operating as a tender barge in association with deep-water permanent template-type drilling platforms on which are mounted standard derrick equipment with drawworks and drive machinery.

Principles embodied in the design of the platforms, for use in depths of water up to 120 ft, however, allow less machinery space than is usually provided for mechanical drive groups on the heavy land-based drilling rigs. In consequence, compactness of the drawworks prime-mover became a major consideration.

Furthermore, it was necessary that the power medium should be largely unaffected by the corrosive nature of lake water and at the same time be self-sustaining from the standpoint of fuel, fresh water, and general supplies for a period of not less than 30 days. It was essential for the machinery to have capacity and characteristics capable of drilling efficiently to the greatest depths envisaged for lake wells. Constructed in Britain, the barge had to withstand an Atlantic crossing while at the same time its dimensions, including a sufficiently shallow draft, were to be such as to enable ready negotiation of the inshore regions of the semi-enclosed waters of Lake Maracaibo.

The basic design of drilling barge "GP-2" is drawn up around a main d-c power plant of 1800-kw capacity, powered by four diesel engines with a combined output of 2792 bhp. Auxiliary power is provided by an a-c plant of 300-kw rating, powered by two diesel engines together having an output of 562 bhp. Total installed diesel power includes d-c and a-c power plants plus independently-driven fire pump, air compressor and an emergency lighting set amounting to 3500 bhp.

The d-c and a-c power plants were manufactured and installed in Britain while certain special items of equipment, including d-c control gear, were purchased in the United States and shipped to Britain for building into the barge during the later stages of construction. In addition, a number of major items of drilling equipment, specially adapted to electric drive, were manufactured in the U. S. and shipped directly to Venezuela for final fitting-out on site.

It will be realized, therefore, that in addition to the problems usually associated with design and construction, the question of proper coordination of specifications between the two continents became a matter of extreme importance especially since the widely dispersed sources of supply and points of assembly were called upon to produce a vessel, which, while not by any means unique in the field of the diesel electric medium for marine drilling, is believed to be the first of its kind

Dimensions of capacity of hull.

Length moulded	158 ft 0 in.
Breadth moulded	80 ft 0 in.
Depth to main deck at sides	10 ft 0 in.
Designed draft	7 ft 6 in.
Total displacement to designed draft	2545 tons

	Tons of 2240 lb	
Casing and drill pipe	290	
Miscellaneous supplies	150	
Mud Chemicals and weighting materials	90	
Diesel oil	388	(based on sp. gr = 1.0)
Fluid drilling mud	400	(based on sp gr = 1.0)
Crude oil	150	(based on sp gr = 1.0)
Fresh water	100	
Sanitary water	3	
Lubricating oil	2	(plus small deck tanks)

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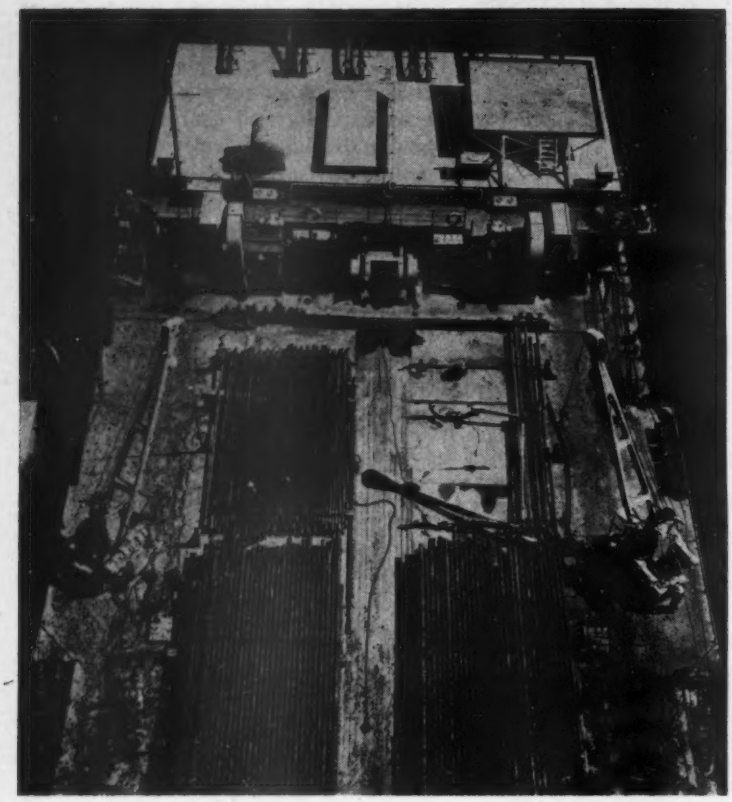

Looking down on pipe deck toward stern showing tandem pipe racking arrangement

Taking on material by means of a 3-ton cargo crane

to be built outside the United States. Builders were Ferguson Brothers of Port Glasgow, Scotland, in collaboration with Metropolitan-Vickers of Manchester, England.

Arrangement of Hull

The hull is flat-bottomed, of welded construction and arranged in the form of three decks, each of which is described separately below. The hull is divided below main deck level by longitudinal and transverse watertight bulkheads to form 21 compartments for fluid storage as follows:

Mud storage (partially open)	10,400 cu ft
Mud suction (open)	3,925 cu ft
Diesel oil	14,000 cu ft
Crude oil	5,380 cu ft
Water ballast	46,000 cu ft
Fresh water	3,590 cu ft

Four cofferdams isolate the two crude oil compartments, while a further cofferdam is situated between the port bow water ballast compartments. A system of longitudinal and transverse framings is employed, there being 62 of the latter, numbered from the stern, the bow being towards the derrick.

The lower deck consists of a pumproom that houses the main slush, standby, high-pressure cement, wash-down and ballast pumps together with control manifolds and various items of ancillary equipment pertaining to mud service. The pumproom is positioned 10 ft 0 in. inboard from each side of the barge and is situated between frames Nos. 17 and 42, this space also accommodating the mud suction and open portions of the mud storage tanks.

The pumproom floor is suitably reinforced with 3 ft 0 in. deep pump and motor seating which are boxed-in to provide added strength. Mud suction and storage tanks open into the pumproom, the former having a capacity of 700 bbl divided into three sections including a 50 bbl "pill" tank. The L-shaped mud storage tanks are two in number with a total capacity of 1858 bbl and surround the suction tanks on three sides. Suitable baffles are built into the storage tanks to obviate mud roll during rough weather, while at the same time the bottoms of all mud tanks are kept free of all internal obstructions.

The main deck is continuous except over the pumproom and open portions of the mud storage and suction tanks. In order to ensure adequate strength over this section, however, stanchions carrying stringers are fitted into the pumproom so as to span the entire open section. Stringers are at main deck level and are finished in the form of walkways for the convenience of operators entering the pumproom, making it unnecessary for any stairways to be negotiated for observation or control of pumps, or for the purpose of checking mud condition in the tanks. The engine room is situated on the main deck at the stern of the barge between frames Nos. 2 and 20, extending across the barge 5 ft 0 in. inboard at either side.

Engine and generator seatings, form the main floor stiffening, the working floor being about 2 ft 0 in. above the main deck. A suitable steel plate enclosure comprises the engine room housing, which is complete with two large roller and two water-tight doors. The same housing incorporates a separate compartment for a diesel-driven fire pump which is accessible by separate entry from the main deck. Between frames Nos. 42 and 52 on the main deck, a store room is set aside for the storage of dry mud chemicals and weighting materials. This store extends across the barge 17 ft 6 in. inboard at either side, and access from the main deck is by means of one water-tight and two large roller doors; communication between the store and the pumproom is by a further watertight door. Hopper mixing facilities are provided in the store room so that weighting and other dry materials can be added to the mud from within the store.

Two delivery chutes are built-in features, being installed between store room and upper deck to facilitate stowage of sacked materials. Electrical and mechanical consumables are stored in two separate rooms located at the forward end of the main deck. Also well forward are the quarters for the drilling crews, together with a

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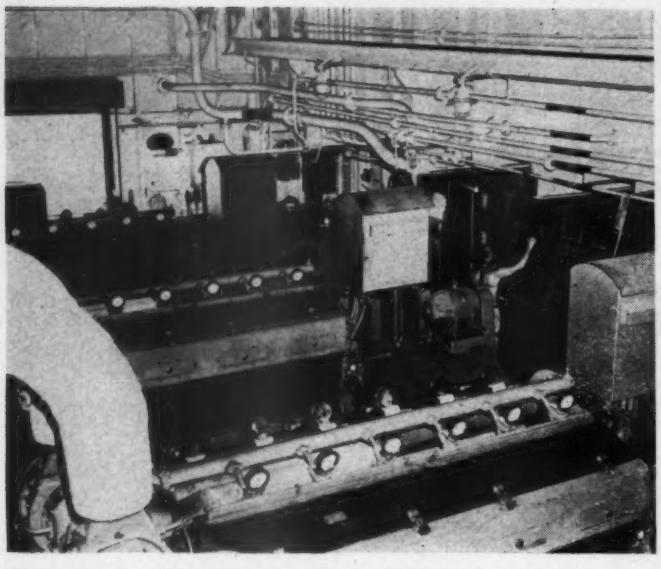
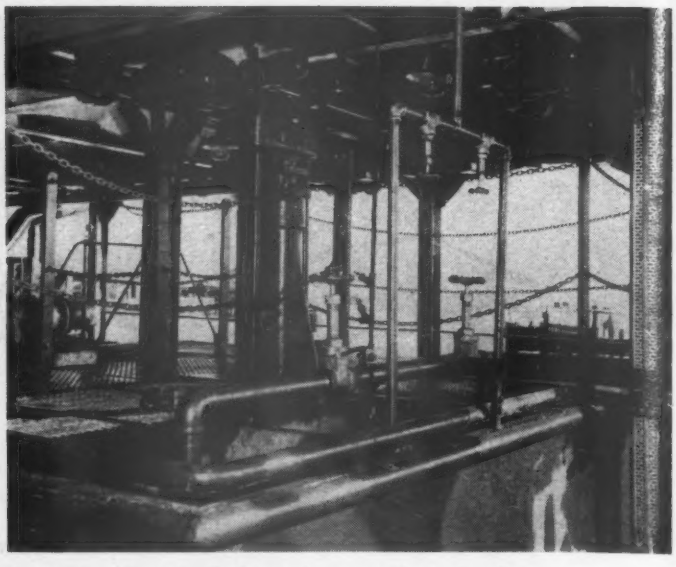


General view of engine room showing log board in background on which are marked the generator assignments



Sand pit with centrally-located pneumatic/hydraulic valve used for dumping sand through barge bottom

small core shed, the latter equipped with means for carrying out routine tests on ditch, mud and more samples on site. Mountings for the vibrating screens are situated at the bow of the barge where a suitable central receptacle is arranged to receive mud returns from the well. To the starboard of the screens is a sand settling pit which can be opened hydraulically or pneumatically to permit disposal of unwanted matter through the barge bottom. Liquid chemical handling equipment is built into and adjacent to the settling pit.

Formation cuttings leaving the cloths of the vibrating screens are allowed to gravitate through discharge flumes opening through the barge bottom. Sample catchers are a built-in feature of the flume combings. Installed in association with the vibrating screens, sand settling pit and chemical equipment is a twin mud-ditch installation extending through the dry chemical store to the mud suction tanks. To the port of the screens is a further raised platform supporting the main terminal board. This provides the means of linking the power supply from the barge to the drilling floor. Locations for four anchor winches are provided, two on each side of the main deck between frames Nos. 37 and 47.

Function of the upper deck is to provide space for tubulars, working tools and normal consumables. The area set aside for tubulars is 4200 sq ft including that occupied by a central wood-surfaced walkways which is laid between two sets of pipe bearers. One crane spindle is installed on each side of the upper deck outside the pipe rack area at frame No. 42. Hatchways are built into the deck to coincide with the minimum working radius of the cranes and open to the chutes leading to the dry chemical store on the main deck. At the rear of the pipe rack area is a safety buffer intended as a precaution against sliding of pipe or other material in the event of the vessel pitching badly in inclement weather. As a further precaution in this connection, suitable pipe locating rods and rail-section stanchions are included as part of the pipe deck equipment. Further towards the stern at pipe rack level is a mounting for a wire line reel, which is flanked on either side by quarters for engineers and senior supervisors.

These quarters include a radio room, wash room, small galley, mess and office facilities plus limited sleeping accommodation. Above the deck houses is a long, narrow, elevated docking bridge which affords good visibility over the entire barge. Anchor winch controls can be manipulated from this position as well as from main deck according to weather condition. Other items located in this general area include two fuel service tanks, one lake water gravity tank, one fresh water cooling tank for engine service, a life boat davit and a pressure tank used in association with the fire fighting installation. A small landing platform is built on the engine house roof for a two-place helicopter.

Engine Room Equipment

The main d-c generating plant comprises four 450-kw 650-rpm single bearing, constant speed, variable-voltage, drip proof generators, designed to provide a full load output at 450 volts. Each generator is compound wound with shunt field separately excited from a top-mounted, vee belt driven, 5 kw 250 v exciter. This arrangement provides the necessary form of drooping characteristic of the generator voltage curve with load increase. Each main d-c generator is driven direct through a solid type coupling by a 12 cylinder, vee, 4-cycle, marine auxiliary diesel engine fitted with an exhaust gas turbocharger. After making allowances for engine room temperature of 50 C and for humidity of 90 per cent the continuous power per engine, amounts to 698 bhp at 650 rpm. Function of the d-c generating equipment is to supply power to the main and standby slush pumps, cement pump, coring reel, drawworks and rotary machine.

Two auxiliary a-c/d-c generator sets each comprise a 150 kw, 600 rpm, single bearing, 0.8 pf, 187 kva, 440 v, 3-phase 60 cycle generator, tandem coupled to which, by means of a flexible coupling, is a 20 kw, 250 v d-c generator for main motor field excitation. Exciters for the a-c generators are top-mounted, being vee-belt driven. Each a-c generator is direct driven through a solid type coupling by a naturally-aspirated, 4-cycle marine auxiliary diesel engine having 7 cylinders in line. Under site conditions the continuous rating per engine is 281 bhp at 600 rpm. The a-c plant is required to furnish barge and derrick lighting, also power to all auxiliary motors, including blowers, anchor winches, mud screens, and cranes. Under normal conditions one auxiliary tandem set is allowed to operate at one time but arrangements have been made, so that in case of emergency, both a-c units can operate in parallel.

Alarm panels afford suitable warning in case of failure of the lubricating oil or cooling water service to the engines. The arrangement comprises a combination of bell, horn, and signal

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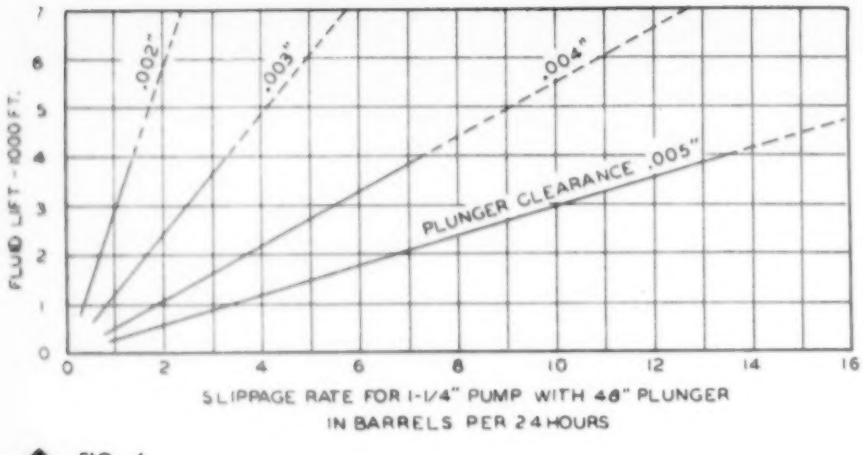
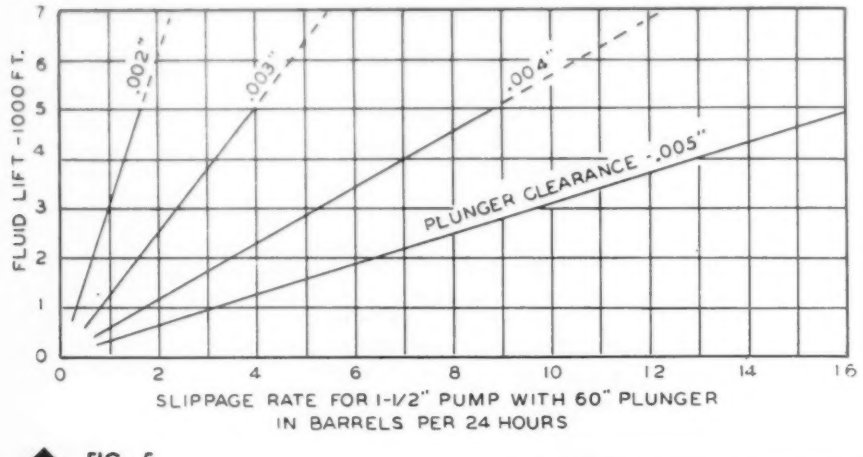


▲ FIG. 4.



▲ FIG. 5

the plunger and decreases as its length is increased. Therefore, doubling the length of the plunger will cut the leakage rate in half.

The other important factor controlling leakage rate is fluid viscosity. *Breakage varies indirectly with the fluid viscosity and decreases as the viscosity increases.* The viscosity of petroleums are dependent on their chemical composition and temperature. Their viscosity will range from approximately 0.5 to over 100 centipoises at bottom hole temperature. In some extreme cases it may approach 1000 centipoises. The viscosity of water is one centipoise at 68 F.

The relationship between API gravity and viscosity for oils produced from the Elk Hills field of California is shown in Fig. 1. This chart is based on data compiled by the Bureau of Mines.[1] As the viscosity of the fluid is influenced by several variables, the relative values of API gravity and viscosity shown in Fig. 1 are not applicable to other crude oils. The general relationship indicating that viscosity increases as the API gravity decreases, however, is true for all crude oils.

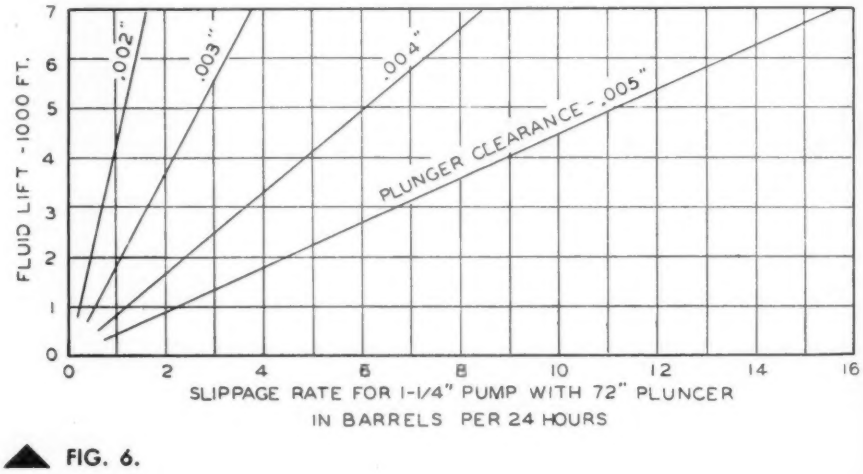
When the fit of the plunger is correctly chosen, the velocity of the fluids slipping past the plunger is usually low. If it is in the range of streamline flow, grooves in the plunger will not materially effect the rate of leakage.

If the fluid velocity produces turbulent flow, grooves will create additional turbulence and cause a slight reduction in the rate of slippage. The principal function of grooves is to facilitate plunger lubrication by providing oil reservoirs.

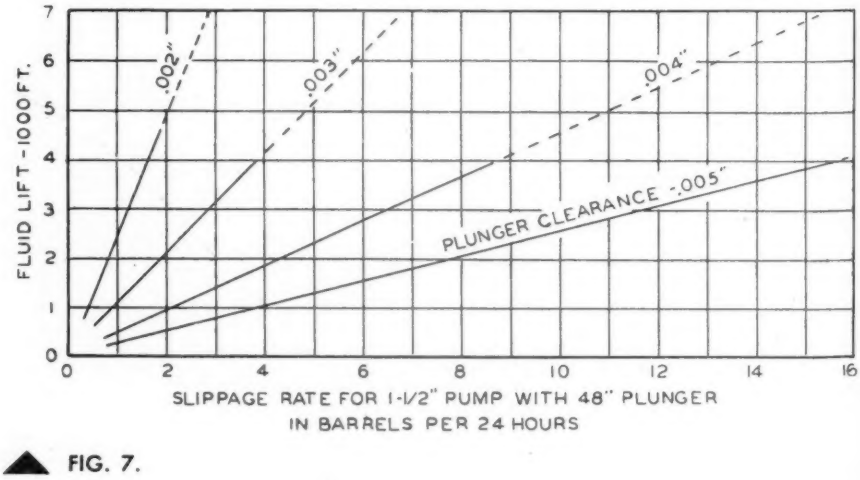
The fact that slippage increases directly with pressure (height of fluid lift) and inversely with plunger length is recognized in practice by providing a definite length of seal for each foot of lift. The usual practice is to provide 12 in. of seal per 1000 ft of depth. This seal length should be increased if paraffin deposits occur in the tubing and flow lines to compensate for the increased pressures resulting from these restrictions. To assure adequate plunger lubrication, the maximum plunger length is commonly set at 6 ft.

The relationship between slippage rate and depth for various lengths of 1¼-in. bore pumps is shown in Fig. 4, 5 and 6. The same information for 1½-in. bore pumps is shown in Fig. 7, 8, and 9.

These charts are based on producing a fluid with a viscosity of 1 centipoise, which corresponds to water at 68 F.



▲ FIG. 6.



▲ FIG. 7.

The actual slippage rates, when producing water from a well, will usually be higher due to its being at a greater temperature.

As the viscosities of most oils are higher than unity, these slippage rates are higher than those found in most wells producing oil. For example, if the viscosity of the well fluid were 10, the slippage rate would be one-tenth of that shown on the charts.

From this data it is apparent that the slippage rates with small amounts of clearance and properly chosen plunger lengths are rather low, but can reach important proportions when the plunger clearance becomes excessive.

Plunger clearance becomes increasingly important as pump bore size is decreased, because the pump displacement decreases as the square of the bore diameter and leakage with the first power of the diameter. Consequently, the percentage of the displacement lost as slippage increases as the bore diameter is decreased.

This becomes especially important in 1 and 1-1/16-in. bore diameter pumps operating at low speeds. Naturally, the limiting value of clearance will be influenced by fluid viscosity, because it determines the leakage rate.

The effect of increasing the plunger clearance on the efficiency of a 1½-in. bore pump producing a one centipoise fluid is shown in Table 1. From this table it is apparent that large values of clearance can cause material losses in pump effiiciency when producing fluids with low viscosities. Naturally, the pump efficiency will be proportionally higher than that shown in the table, if the viscosity of the fluid is greater than unity.

In addition to controlling the rate of fluid slippage the fit between the plunger and barrel determines the size of sand particles which can enter this space. Consequently, the magnitude of the clearance could influence the ability of the pump to produce abrasive fluids.

If the clearance were sufficiently small to exclude all sand particles, they could not enter and cause plunger and barrel wear. The feasibility of this practice can be evaluated by making size clasisfication studies of oil well sands.

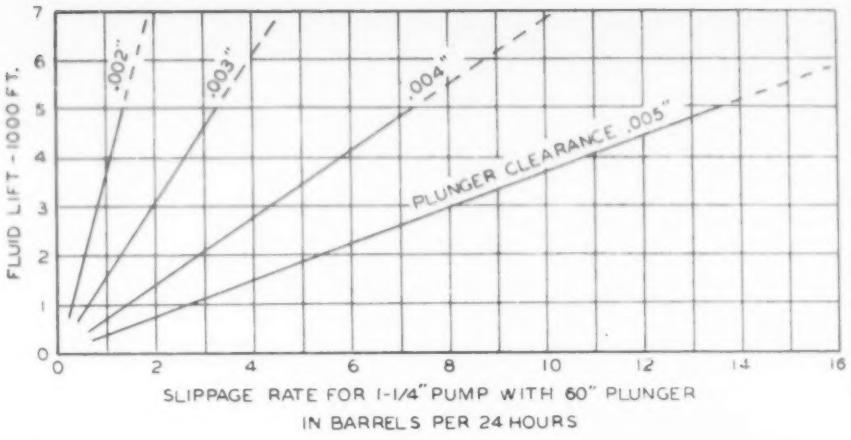


FIG. 8.

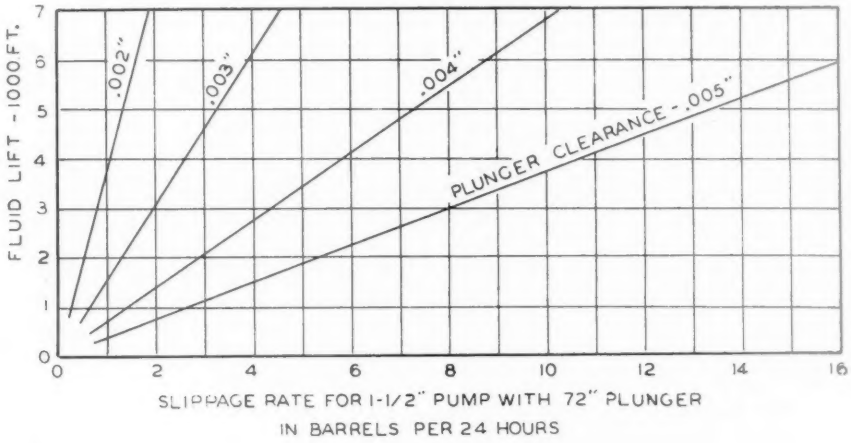


FIG. 9.

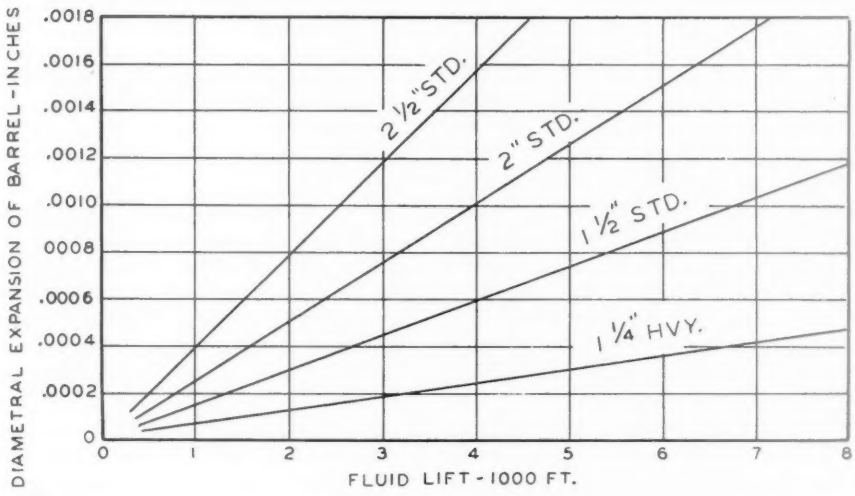


FIG. 10.

TABLE 1. 1½-in. bore pump lifting water from any depth with plunger length equal to 12-in. per 1000 ft of lift.

Pump stroke and speed	Pump displacement bbl/24 hr	Slippage as a percentage of displacement for plunger clearance as shown				
		.002	.003	.004	.005	.006
54" 20 SPM	283	0.58	1.39	3.12	5.75	9.68
54" 15 SPM	212	0.77	1.86	4.16	7.68	12.9
54" 10 SPM	141	1.16	2.79	6.26	11.5	19.4
44" 20 SPM	230	0.71	1.71	3.84	7.08	11.9
44" 15 SPM	173	0.94	2.28	5.21	9.42	15.9
44" 10 SPM	115	1.42	3.42	7.68	14.2	23.8
34" 20 SPM	178	0.92	2.21	4.96	9.16	15.4
34" 15 SPM	133	1.23	2.96	6.65	12.3	20.6
34" 10 SPM	89	1.83	4.42	9.93	18.3	30.8

In the discussion of a paper by Coberly,[2] Stanley Gill presented the sand particle classification data shown in Table 2.

This classification data shows per cent of the total sand sample which was retained on a screen with openings of the size shown. Considering the 90 per cent column, 10 per cent by weight of the sand particles in the sample were smaller than the sizes shown.

In view of the small size of these

TABLE 2.

Field	40 Per cent size, inches	90 Per cent size, inches
Corpus Christi	0.0108	0.0083
	0.0066	0.0017
Barbers Hill	0.008	0.0029
Manvel	0.0105	0.0029
Damon	0.0062	0.0023
Louisiana	0.0064	0.0037
Humble	0.0105	0.0043
Pierce-Junction	0.0062	0.0019
Seven Sisters	0.0066	0.0044
	0.0063	0.0041
	0.0076	0.0023
Moore	0.0052	0.0034
Goose Creek	0.0094	0.0029

The Author

Kenneth N. Mills is a practicing oil consultant in Tulsa, Oklahoma. He began his career with American Manufacturing Company following graduation from Rice Institute in 1933. In 1940 he joined Bethlehem Supply Company as chief engineer.

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particles it is impractical to reduce the clearance between the plunger and barrel to a value which would exclude all of these particles. This practice might be practical with some California sands because their minimum particle size is much greater than those found in Gulf Coast unconsolidated sands.

As all of the sand particles cannot be prevented from entering the space between the plunger and barrel, grooved plungers should not be used in wells producing sand. If the plunger is grooved, the sand particles will tend to collect in the grooves and form a bridge between the base of the groove and the barrel. This will cause excessive barrel and plunger wear and may freeze the plunger in the barrel. If the plunger is not grooved, the sand particles entering the space between the plunger and barrel will have a better chance to pass through without inflicting damage on these parts.

The minimum clearance between the plunger and barrel is a function of fluid viscosity, because some leakage is essential for plunger lubrication. If the pump is not fitted with this clearance, wear will provide the clearance. This is undesirable, because the resulting surface has poor wear-resisting characteristics.

When sliding surfaces become mated through the normal wearing-in process, they develop a smooth work-hardened surface that is resistant to galling. If they wear in through abnormal processes, such as insufficient lubrication, resulting surfaces are rough as they are produced by highly localized galling, and they may never develop the smooth work-hardened surface produced by normal wear.

A general value for minimum clearance cannot be established, because it is dependent on the accuracy of the parts, their surface finish and fluid viscosity.

The minimum plunger clearance that will permit good plunger lubrication in a well that flows by heads is greater than the minimum permissible clearance in a normal pumping well. When the well is flowing, the pressure differential between the two ends of the plunger is zero. Consequently, the rate of fluid slippage past the plunger is zero, and this fluid is not available for plunger lubrication.

Under these conditions the plunger must depend on the oil's adhering to the barrel for lubrication, and the clearance must be sufficient to permit the plunger to "ride over" this film. If it is too small, this oil film may be scraped off ahead of the plunger. In this event the plunger will not receive sufficient lubrication, and excessive wear will occur.

Experience has shown that plunger friction is a predominating factor influencing the volume of fluid that can be produced from wells being pumped at maximum rates. In wells of this type relatively large values of clearance must be used to assure free plunger travel.

If the plunger fit is too close, excessive friction forces will be created. This will subject the sucker rods to compressive force that will cause the sucker rods to buckle. The buckling of the rods will reduce the plunger travel and, therefore, the pump displacement. It will also subject the sucker roads to adverse loads which will cause premature rod failures.

When the pump is fitted with a relatively loose plunger, the efficiency loss resulting from the higher slippage is more than compensated for by increased plunger travel.

The principal effect of high bottom hole temperature is to decrease the leakage rate. As both the plunger and pump barrel are immersed in the same fluid, it is reasonable to expect them to have approximately the same temperature. The practice, therefore, of employing looser fits in pumps that are applied to high bottom hole temperature wells is in error. The fallacy of this practice is further illustrated by comparison of the co-efficients of expansion of steel and alloy cast iron.

The co-efficient of expansion steel is 11.7 by 10^{-6} in. per inch per degree Centigrade, and that for alloy cast iron is 10.5 by 10^{-6}. If the barrel is made of steel and the plunger is of the composite construction with alloy cast iron sections, increasing the temperature of the pump will increase the clearance between the plunger and the barrel. If the temperature change were 100 F, this increase in clearance would be only one-tenth of a thousandth of an inch in 1½-in. bore pump, which is insignificant. If the pump had a liner barrel with cast iron liners, the clearance would be decreased by a like amount.

The normal operating cycle of a pump subjects its barrel to high differential pressures which either tend to increase or decrease the clearance between plunger and barrel. If the pump has a bottom hold-down, the differential pressure tends to reduce the clearance. The magnitude of this effect is shown graphically in Fig. 10.

The tubes designated as standard have ⅛-in. thick wall which is commonly found on the heavy wall barrel pumps. In general, the maximum practical depth for each bore pump is limited by rod and tubing stretch.

When these limits are considered, it is apparent that the maximum increase or decrease in clearance resulting from differential pressure is approximately .001-in. This effect is not worthy of consideration in the average installation, because its magnitude will be materially less than this maximum value.

As the optimum value of plunger clearance is dependent on both the viscosity of the fluid and the performance characteristics of the well, a definite value for the most desirable fit cannot be established.

If the pump is not fitted with sufficient clearance for the prevailing well conditions, it will wear at a rapid rate until the required clearance is established. Reasonable values of clearance which permit sufficient leakage for effective lubrication will not adversely effect the efficiency of the pump, and will probably extend its life.

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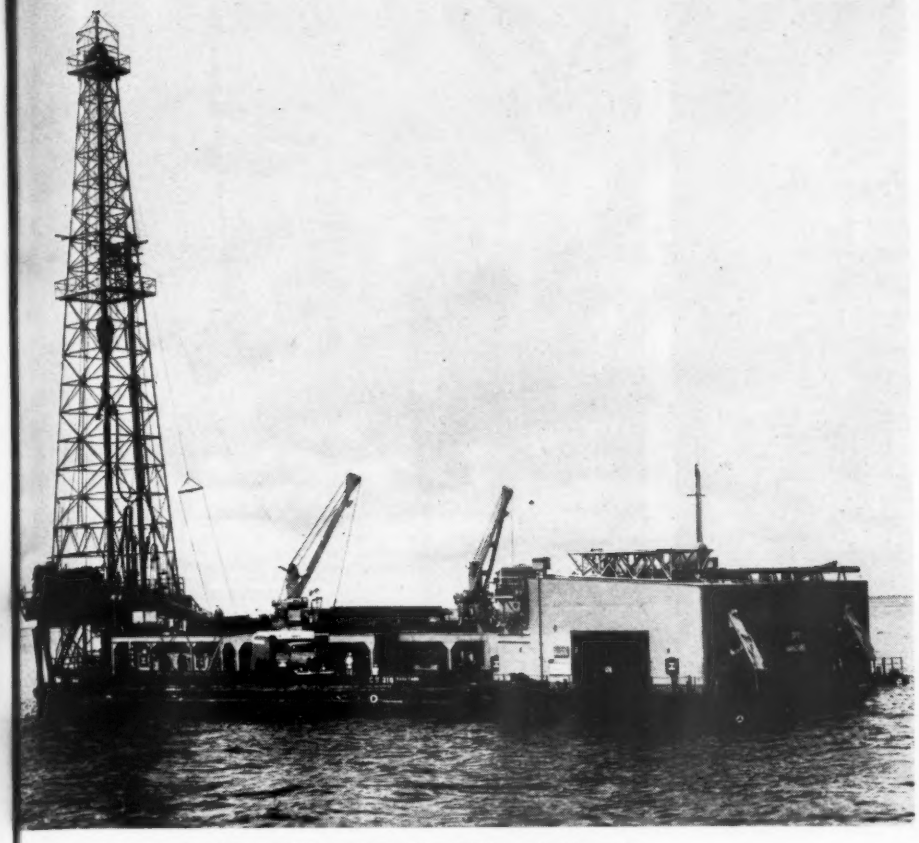
2. "Selection of Screen Openings for Unconsolidated Sands," by J. C. Coberly, API Drilling and Production Practice, 1937.



"GP-2" in operating position alongside drilling platform.

DRILLING BARGE Designed for Lake Maracaibo Operations

Vessel serves as tender in association with deep-water platform-mounted equipment in South American development operation

THE diesel electric drilling barge "GP-2" of the Compania Shell de Venezuela Ltd. was designed for drilling on Lake Maracaibo. Delivery of this vessel from Britain and its introduction into lake operations marked the consummation of joint efforts of engineers in Europe, United States, and Venezuela over a period of several years. The essential features of design, as laid down at the outset, called for a vessel capable of operating as a tender barge in association with deep-water permanent template-type drilling platforms on which are mounted standard derrick equipment with drawworks and drive machinery.

Principles embodied in the design of the platforms, for use in depths of water up to 120 ft, however, allow less machinery space than is usually provided for mechanical drive groups on the heavy land-based drilling rigs. In consequence, compactness of the drawworks prime-mover became a major consideration.

Furthermore, it was necessary that the power medium should be largely unaffected by the corrosive nature of lake water and at the same time be self-sustaining from the standpoint of fuel, fresh water, and general supplies for a period of not less than 30 days. It was essential for the machinery to have capacity and characteristics capable of drilling efficiently to the greatest depths envisaged for lake wells. Constructed in Britain, the barge had to withstand an Atlantic crossing while at the same time its dimensions, including a sufficiently shallow draft, were to be such as to enable ready negotiation of the inshore regions of the semi-enclosed waters of Lake Maracaibo.

The basic design of drilling barge "GP-2" is drawn up around a main d-c power plant of 1800-kw capacity, powered by four diesel engines with a combined output of 2792 bhp. Auxiliary power is provided by an a-c plant of 300-kw rating, powered by two diesel engines together having an output of 562 bhp. Total installed diesel power includes d-c and a-c power plants plus independently-driven fire pump, air compressor and an emergency lighting set amounting to 3500 bhp.

The d-c and a-c power plants were manufactured and installed in Britain while certain special items of equipment, including d-c control gear, were purchased in the United States and shipped to Britain for building into the barge during the later stages of construction. In addition, a number of major items of drilling equipment, specially adapted to electric drive, were manufactured in the U. S. and shipped directly to Venezuela for final fitting-out on site.

It will be realized, therefore, that in addition to the problems usually associated with design and construction, the question of proper coordination of specifications between the two continents became a matter of extreme importance especially since the widely dispersed sources of supply and points of assembly were called upon to produce a vessel, which, while not by any means unique in the field of the diesel electric medium for marine drilling, is believed to be the first of its kind

Dimensions of capacity of hull.

Length moulded	158 ft 0 in.
Breadth moulded	80 ft 0 in.
Depth to main deck at sides	10 ft 0 in.
Designed draft	7 ft 6 in.
Total displacement to designed draft	2545 tons

	Tons of 2240 lb	
Casing and drill pipe	290	
Miscellaneous supplies	150	
Mud Chemicals and weighting materials	90	
Diesel oil	388	(based on sp. gr = 1.0)
Fluid drilling mud	400	(based on sp gr = 1.0)
Crude oil	150	(based on sp gr = 1.0)
Fresh water	100	
Sanitary water	3	
Lubricating oil	2	(plus small deck tanks)

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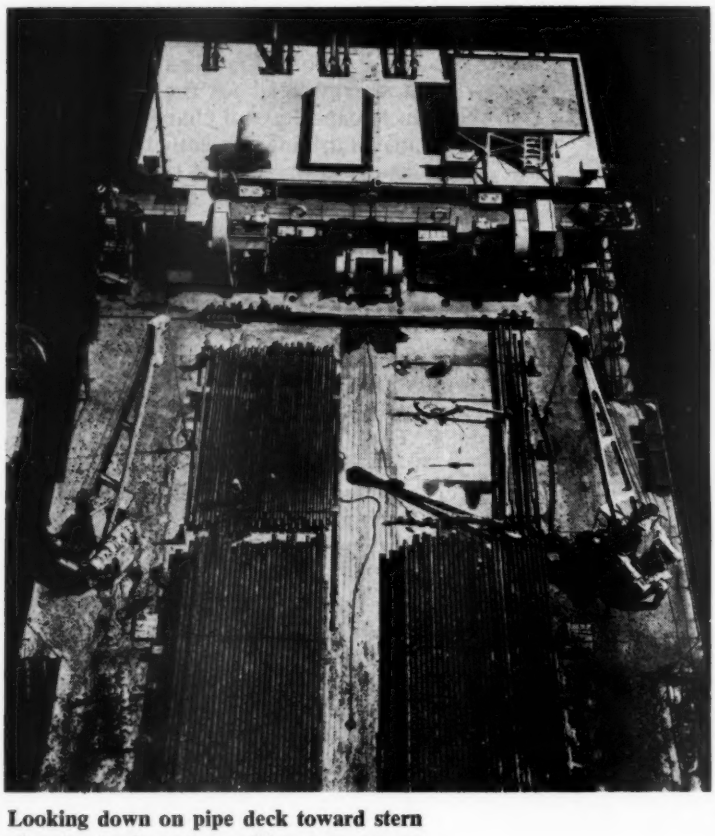

Looking down on pipe deck toward stern showing tandem pipe racking arrangement

Taking on material by means of a 3-ton cargo crane

to be built outside the United States. Builders were Ferguson Brothers of Port Glasgow, Scotland, in collaboration with Metropolitan-Vickers of Manchester, England.

Arrangement of Hull

The hull is flat-bottomed, of welded construction and arranged in the form of three decks, each of which is described separately below. The hull is divided below main deck level by longitudinal and transverse watertight bulkheads to form 21 compartments for fluid storage as follows:

Mud storage (partially open)	10,400 cu ft
Mud suction (open)	3,925 cu ft
Diesel oil	14,000 cu ft
Crude oil	5,380 cu ft
Water ballast	46,000 cu ft
Fresh water	3,590 cu ft

Four cofferdams isolate the two crude oil compartments, while a further cofferdam is situated between the port bow water ballast compartments. A system of longitudinal and transverse framings is employed, there being 62 of the latter, numbered from the stern, the bow being towards the derrick.

The lower deck consists of a pumproom that houses the main slush, standby, high-pressure cement, wash-down and ballast pumps together with control manifolds and various items of ancillary equipment pertaining to mud service. The pumproom is positioned 10 ft 0 in. inboard from each side of the barge and is situated between frames Nos. 17 and 42, this space also accommodating the mud suction and open portions of the mud storage tanks.

The pumproom floor is suitably reinforced with 3 ft 0 in. deep pump and motor seating which are boxed-in to provide added strength. Mud suction and storage tanks open into the pumproom, the former having a capacity of 700 bbl divided into three sections including a 50 bbl "pill" tank. The L-shaped mud storage tanks are two in number with a total capacity of 1858 bbl and surround the suction tanks on three sides. Suitable baffles are built into the storage tanks to obviate mud roll during rough weather, while at the same time the bottoms of all mud tanks are kept free of all internal obstructions.

The main deck is continuous except over the pumproom and open portions of the mud storage and suction tanks. In order to ensure adequate strength over this section, however, stanchions carrying stringers are fitted into the pumproom so as to span the entire open section. Stringers are at main deck level and are finished in the form of walkways for the convenience of operators entering the pumproom, making it unnecessary for any stairways to be negotiated for observation or control of pumps, or for the purpose of checking mud condition in the tanks. The engine room is situated on the main deck at the stern of the barge between frames Nos. 2 and 20, extending across the barge 5 ft 0 in. inboard at either side.

Engine and generator seatings, form the main floor stiffening, the working floor being about 2 ft 0 in. above the main deck. A suitable steel plate enclosure comprises the engine room housing, which is complete with two large roller and two water-tight doors. The same housing incorporates a separate compartment for a diesel-driven fire pump which is accessible by separate entry from the main deck. Between frames Nos. 42 and 52 on the main deck, a store room is set aside for the storage of dry mud chemicals and weighting materials. This store extends across the barge 17 ft 6 in. inboard at either side, and access from the main deck is by means of one water-tight and two large roller doors; communication between the store and the pumproom is by a further watertight door. Hopper mixing facilities are provided in the store room so that weighting and other dry materials can be added to the mud from within the store.

Two delivery chutes are built-in features, being installed between store room and upper deck to facilitate stowage of sacked materials. Electrical and mechanical consumables are stored in two separate rooms located at the forward end of the main deck. Also well forward are the quarters for the drilling crews, together with a

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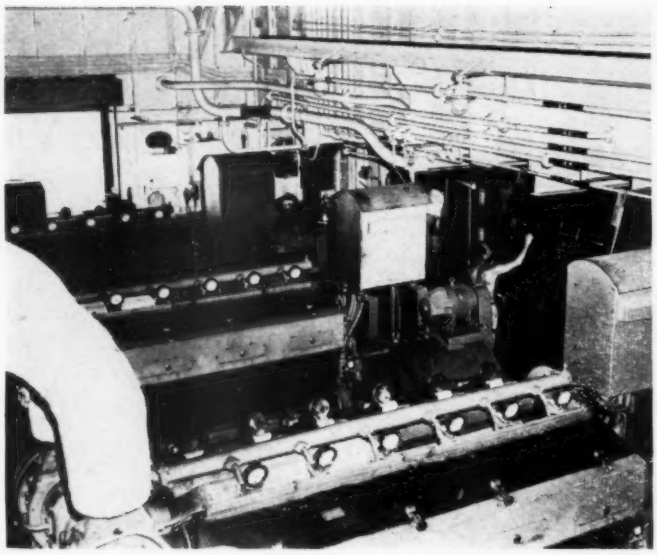
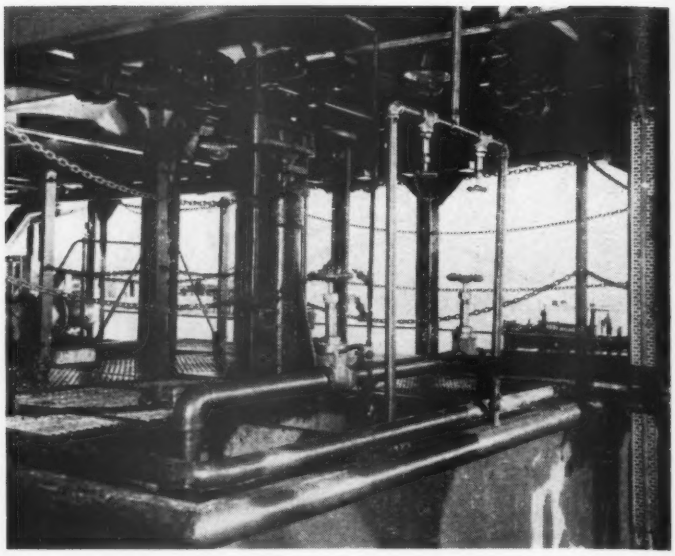


General view of engine room showing log board in background on which are marked the generator assignments



Sand pit with centrally-located pneumatic/hydraulic valve used for dumping sand through barge bottom

small core shed, the latter equipped with means for carrying out routine tests on ditch, mud and more samples on site. Mountings for the vibrating screens are situated at the bow of the barge where a suitable central receptacle is arranged to receive mud returns from the well. To the starboard of the screens is a sand settling pit which can be opened hydraulically or pneumatically to permit disposal of unwanted matter through the barge bottom. Liquid chemical handling equipment is built into and adjacent to the settling pit.

Formation cuttings leaving the cloths of the vibrating screens are allowed to gravitate through discharge flumes opening through the barge bottom. Sample catchers are a built-in feature of the flume combings. Installed in association with the vibrating screens, sand settling pit and chemical equipment is a twin mud-ditch installation extending through the dry chemical store to the mud suction tanks. To the port of the screens is a further raised platform supporting the main terminal board. This provides the means of linking the power supply from the barge to the drilling floor. Locations for four anchor winches are provided, two on each side of the main deck between frames Nos. 37 and 47.

Function of the upper deck is to provide space for tubulars, working tools and normal consumables. The area set aside for tubulars is 4200 sq ft including that occupied by a central wood-surfaced walkways which is laid between two sets of pipe bearers. One crane spindle is installed on each side of the upper deck outside the pipe rack area at frame No. 42. Hatchways are built into the deck to coincide with the minimum working radius of the cranes and open to the chutes leading to the dry chemical store on the main deck. At the rear of the pipe rack area is a safety buffer intended as a precaution against sliding of pipe or other material in the event of the vessel pitching badly in inclement weather. As a further precaution in this connection, suitable pipe locating rods and rail-section stanchions are included as part of the pipe deck equipment. Further towards the stern at pipe rack level is a mounting for a wire line reel, which is flanked on either side by quarters for engineers and senior supervisors.

These quarters include a radio room, wash room, small galley, mess and office facilities plus limited sleeping accommodation. Above the deck houses is a long, narrow, elevated docking bridge which affords good visibility over the entire barge. Anchor winch controls can be manipulated from this position as well as from main deck according to weather condition. Other items located in this general area include two fuel service tanks, one lake water gravity tank, one fresh water cooling tank for engine service, a life boat davit and a pressure tank used in association with the fire fighting installation. A small landing platform is built on the engine house roof for a two-place helicopter.

Engine Room Equipment

The main d-c generating plant comprises four 450-kw 650-rpm single bearing, constant speed, variable-voltage, drip proof generators, designed to provide a full load output at 450 volts. Each generator is compound wound with shunt field separately excited from a top-mounted, vee belt driven, 5 kw 250 v exciter. This arrangement provides the necessary form of drooping characteristic of the generator voltage curve with load increase. Each main d-c generator is driven direct through a solid type coupling by a 12 cylinder, vee, 4-cycle, marine auxiliary diesel engine fitted with an exhaust gas turbocharger. After making allowances for engine room temperature of 50 C and for humidity of 90 per cent the continuous power per engine, amounts to 698 bhp at 650 rpm. Function of the d-c generating equipment is to supply power to the main and standby slush pumps, cement pump, coring reel, drawworks and rotary machine.

Two auxiliary a-c/d-c generator sets each comprise a 150 kw, 600 rpm, single bearing, 0.8 pf, 187 kva, 440 v, 3-phase 60 cycle generator, tandem coupled to which, by means of a flexible coupling, is a 20 kw, 250 v d-c generator for main motor field excitation. Exciters for the a-c generators are top-mounted, being vee-belt driven. Each a-c generator is direct driven through a solid type coupling by a naturally-aspirated, 4-cycle marine auxiliary diesel engine having 7 cylinders in line. Under site conditions the continuous rating per engine is 281 bhp at 600 rpm. The a-c plant is required to furnish barge and derrick lighting, also power to all auxiliary motors, including blowers, anchor winches, mud screens, and cranes. Under normal conditions one auxiliary tandem set is allowed to operate at one time but arrangements have been made, so that in case of emergency, both a-c units can operate in parallel.

Alarm panels afford suitable warning in case of failure of the lubricating oil or cooling water service to the engines. The arrangement comprises a combination of bell, horn, and signal

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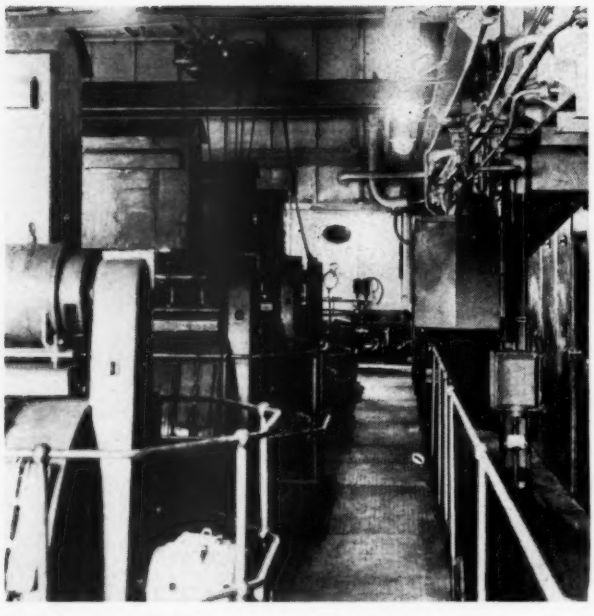
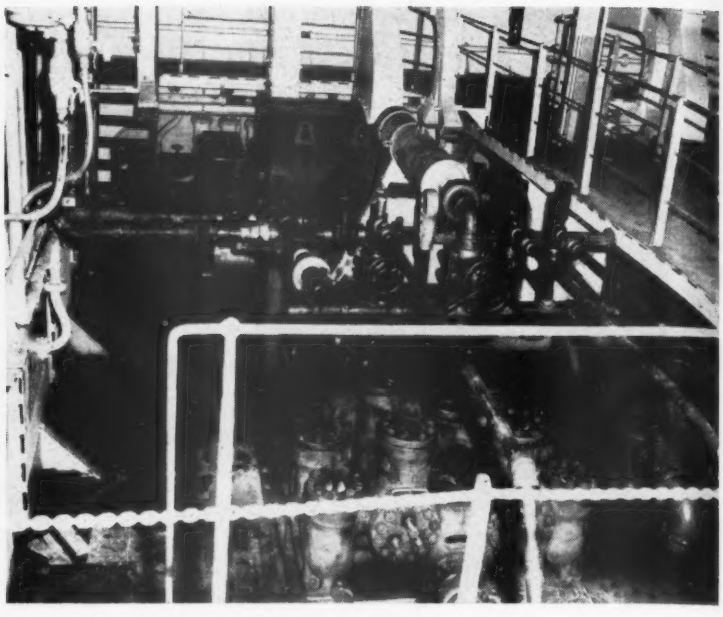


Looking across beam of barge in engine room showing main d-c generators at left and main control panel at right



One of the slush pumps showing walkways at main deck level and pump controls at upper left. These controls are duplicated at the driller's position

lamp warnings, the system being operable in the event of oil pressure falling to 10 psi or oil temperature rising to 60 C. Warning is given also when lake water temperature the cooling circuit exceeds 32 C and when the temperature of the fresh cooling water rises beyond 82 C.

The main control panel is designed to control all of the main d-c equipment including generators, drawworks, slush pump, cement pump, rotary machine and coring reel motors. Included in the main panel are strip recording voltmeters and ammeters which are connected to the generator circuits. The control gear is also incorporated as part of the main control group. The auxiliary panel controls the two auxiliary a-c generators and the two 20 kw generators used for main motor field excitation. A paralleling synchroscope is provided together with two oil immersed 15 kva, 440-110/220 v transformers, which are connected to feeder panels in the control board. Lighting circuits of 110 v, also means of supplying a-c power to an outside source in case of emergency, are incorporated in the control. A further auxiliary 18 circuit panel for anchor winches, cranes, etc., completes the control equipment as installed in the engine room.

Main engine cooling is accomplished by an enclosed fresh water system served by two (one standby) electrically-driven centrifugal pumps in conjunction with the header tank at upper deck level. Two heat exchangers in monel and gunmetal and two 15 hp electrically-driven centrifugal pumps are installed in the lake water system, each combination being of adequate capacity for cooling the fresh water circulated through the six engines. Heat extraction rate is 7,550,000 Btu's per hour/unit. Engine lubrication is by wet sump, supplied by a lubricating oil supply tank of 500 gal capacity, which is situated in an elevated position within the engine room. Two drain tanks for dirty lubricating oil are housed one each in the port and starboard cofferdams. One 4 hp electrically-driven lubricating oil transfer pump plus one 3 hp standby, are employed for general handling of lubricating oil, including the discharge of used oil and the taking on of new supplies. The diesel oil system comprises two (one standby) 2 hp electrically driven transfer pumps, two 1400 gal service tanks at upper deck level, and one centrifugal purifier, electrically operated and capable of handling 200 gal per hour.

Other auxiliaries in the engine room include engine starting equipment in the form of one electrically driven two-stage, single-acting, air compressor having a free-air delivery of 60 ft .3 at 575 rpm. A similar compressor operating at 1000 rpm and rated at 106 ft .3 is powered by a 9.65 litre diesel engine and applied to initial engine starting.

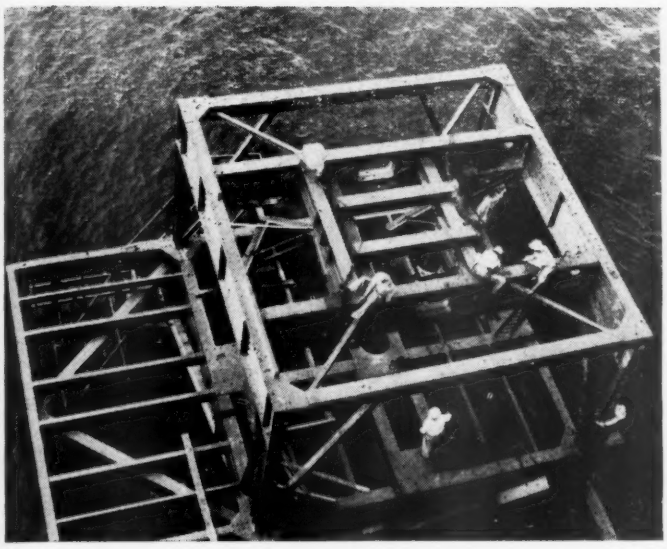
Two air receivers each of 100 ft .3 capacity and 300 psi rating provide air storage for engine starting and general service. Two sanitary and bilge pumps, self-priming centrifugal type are installed, electrically-driven by 8 hp motors. Two 2.5 hp fresh water pumps, also electrically-driven serve the culinary fawcets and drinking water fountains throughout the drilling barge.

A small self-contained lighting set of 5 kva rating powered by a diesel engine is situated on an elevated gallery and is available for emergency lighting in the event of failure of the main supply.

The fire pump is situated in a separately enclosed section of the engine room and comprises a three-stage centrifugal pump powered by a 9.65 litre diesel engine. Rating of fire pump is 500 gpm at 300 ft hd.

Pump Room Equipment

The two 8-½ in by 16 in. main slush pumps are each powered by an 800 hp 450 v, 720 rpm d-c motor capable of momentary peak rating of 1330 hp and speed variation down to 72 rpm by generator voltage control. Each pump is fitted with automatic rod lubrication and is equipped with a pulsation dampener. The standby pump is 7-¼ by 12 in. and powered by a 150 hp, 450 v, 900 rpm d-c motor capable of speed variation down to 90 rpm. For cementing and other high pressure services a six-cylinder pump is provided, powered by a 300 hp, 450 v, 750 rpm d-c motor capable of speed variation down to 75 rpm. All d-c motors in the pumproom are force ventilated and provided with individual controls at walkway level. A feature of the suction manifolding is a 10 in. seavalve to allow direct lake suction by the slush pumps as required. Two vertical propeller mud mixers are installed one each in the mud suction tanks. Each of the mixers is powered by a 25-hp electric motor.



Assembling drilling platform on foundation

Helicopter takes off from roof of the Maracaibo office

Also installed in the pumproom are two (one standby) 10 hp electrically driven ballast pumps arranged to draw from lake, ballast tanks, pump and engine room bilges and cofferdams. Two lake water rig service pumps are located in the pumproom and are 12.5 hp dual motor "Mono" type.

Deck Equipment

Four 25 hp electrically driven anchor winches are installed on the main deck. Each winch has a drum capacity of 240 fathoms of 1¼ in. o-d wire line and maximum line pull at bare drum is 18,000 lb. Four anchors each weighing 14,000 lb are employed together with conventional single and double warping guides. Four special screw type cable clamps are fitted as supplementary means of holding the anchor lines, thus relieving the line-load on the winch drums when the barge is anchored. The two electrically operated deck cargo cranes are rated at 3 tons at 25 ft radius and are capable of luffing, hoisting, and slewing with motors of 7½, 28, and 12 hp respectively. Central blower equipment is made up of two sets (one standby) of ventilating fans, each powered by one 25 hp electric motor and complete with filters. By means of a central blower trunk and various ducting systems, ventilation at the rate of 18,000 ft per minute is provided to all d-c pump motors while at the same time providing general clean air ventilation in the pumproom. A core reel with a drum capacity of 17,500 ft of ⅝ in. o-d wire line is powered by a 150 hp motor separately ventilated by top-mounted blower. Unlike the other auxiliaries on the barge, this motor is on the d-c circuit and is capable of speed variation from 900-90 rpm by virtue of generator voltage control.

Drilling Floor Equipment

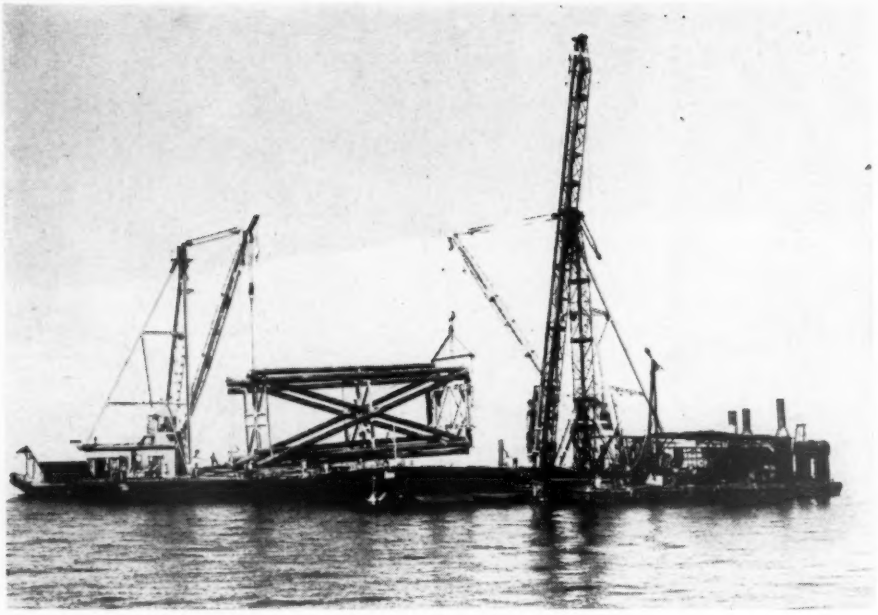
The drilling floor equipment operating in direct association with barge GP-2 consists of a drawworks with special controls and shunt wound motor drive. In addition there is an independent rotary unit comprising a 20½ in. rotary, direct coupled through flexible coupling to a shunt wound motor. The drawworks motor is 800 hp, 450 v, 720 rpm d-c capable of momentary peak rating of 1330 hp and speed variation down to 72 rpm by means of generator voltage control. Self-contained forced ventilation is provided by a top-mounted 7 hp flameproof a-c motor, the air intake ducting being extended outside the floor area. The prime mover for the rotary table is 300 hp, 450 v, 750 rpm d-c capable of similar speed variation and also fitted with self-contained top-mounted forced ventilation, in this case by means of a 2 hp flameproof a-c motor with similarly extended air intake ducting. Floor controls take the form of (a) cabinet with selector levers for main d-c generators, (b) a group of 4 hand wheels for drawworks, rotary and two slush pumps, (c) foot operated spin-out switch for rotary machine. These controls are supplemented by three instruments located in a single panel at the driller's position, showing drawworks amperes, and rotary table volts and amperes.

The electrical and communications link between barge and platform is by means of 15 single and multi-conductor cables for main power, a-c supply, control, and telephone. These cables are suitably suspended between two twin arms carrying suspension cradles. Two massive terminal boards each with 15 receptacles provide means of connection between barge and floor, the barge-mounted board incorporating quick-release features to enable easy disconnection or safe pull-out in case of emergency. A telephone is provided on the drilling platform and others at various vantage points on the barge, the whole communications system reaching a high level of efficiency by the addition of a loud hailer circuit and ship to shore radio.

Observations on Operation

A marked high degree of flexibility is afforded by the selector system which allows available generator capacity to be quickly assigned to various operations according to power demand. By means of the floor-mounted selectors and hand wheel controls the driller assumes complete control over all main machinery including the main slush pumps which are naturally not visible from the derrick floor. In this connection an interlocking system prevents accidental operation of any main pump by the driller when same is being worked on or otherwise unfit for service. Although the inherent features of the power and control systems make possible a wider variation in generator assignment, the present arrangements for selection are somewhat simplified to allow any one or two main generators to be applied to main pump or to drawworks duty as required; either or both of the other two main generators are then available for associated duties.

Smooth speed control is noticeable and has been likened to steam in its high torque at low speed characteristics. The rate of acceleration from standstill is at least equal, throughout the load range, to that of heavy-duty steam and power equipment employed in allied operations in the area. Finger tip con-



Foundation jacket being lifted ready for placing in position at well site

trol is available to the driller at all times, moreover, the characteristics of the control system automatically hold the loads on motors, generators and engines within safe limits.

Power requirements under the conditions encountered on the lake program in which "GP-2" has been engaged are of interest.

Interpretation of typical volt and ampere strip chart records taken during round-trips from depths about 7,300 ft indicate that the power demand on the two generators assigned to the draw-works reached a maximum of 790 hp during the pulling-out cycle. However, the same records clearly show that the horse-power requirements bear little relationship to the actual hook loads, as recorded by the weight indicator charts, since the driller, in making use of higher hoisting gears further up the hole has called for as much, and occasionally more power at the shallow depths than near bottom.

Furthermore, it is noted that when a normal degree of caution is exercised when pulling through troublesome sections of the hole, the power demand for hoisting can be relatively low. Average demand over a typical pulling-out operation from 7300 ft amounted to 695 hp at a mean hoisting rate, with 8-lines strung, of 192 ft per minute. Horsepower readings ranged from 585 to 790. With a maximum hook load of 140,000 lb a hoisting speed of 180 ft per minute has been attained, this representing 95 per cent of the theoretical performance in HI-LO gear assuming 75 per cent efficiency between motor and hook.

During the period under observation the bit weights and rotating speeds were uniform within narrow limits. Jet type rock bits in 9⅝-in. size were employed throughout the intervals over which power measurements were examined. In the case of a strip chart record taken from 5000 ft to 7300 ft in 9⅝ in. hole with 5 in. o-d drillpipe, the weight-on-bit loads varied from 30,000 lb-40-000 lb and rotating speeds from 65-75 rpm. With 30,000 lb on bit, the average power demand was 94 hp, which increased to 119 hp at 35,000 lb bit load and further to a peak of 188 hp at 40,000 lb bit load. The rotary table power records so far obtained give no indication that power requirements will increase substantially with depth, in fact, present indications are that as far as horsepower is concerned, the demand for a given rpm, pipe size, bit size, and weight at 5000 ft is within 5 per cent of that required at 7300 ft.

The main slush pump performance over the same interval showed stroking rates from 34 to 51 spm representing 57 to 92 per cent of rated (not maximum) motor speed. Pressures recorded ranged from 600-1600 psi, under which conditions the power demand by one main slush pump was between 300 hp and 680 hp with an average of 548 hp.

Ready acceptance by the drilling crews of "GP-2" speaks well of its convenience, power, and handling characteristics. Drilling personnel in the operations of the Compania Shell de Venezuela Ltd. are well versed in the operation of the latest types of heavy power equipment and it is felt that the introducion of "GP-2" will serve to advance the already high standard of drilling operations. * * *

Minnesota Silica Mined for Use In Nation's Oil Fields

A deposit of pure silica sand that is expected to be of great value to the oil industry is now being developed 60 miles south of Minneapolis and St. Paul, Minnesota.

Described as the "purest deposit of silica sand ever discovered in the nation," the sand is highly in demand for hydraulic fracturing.

The deposit underlies some 450 acres south of LeSueur, Minnesota. Construction has begun on a $300,000 processing plant which will produce 500 tons (10 freight carloads) of silica sand daily.

This plant, built by the Silica Sand Corporatiotn, later will be expanded to a capacity of 20 carloads daily. The company's present payroll will expand to include more than 20 with the operation of two shifts on a year-round basis.

The sand deposit has been known for more than 30 years. Recent explorations and tests have shown its size and the easy accessibility.

The exploration of only 35 acres by the E. J. Longyear Company, Minneapolis mining engineer firm, indicated enough sand to last 13 years if 1000 tons were processed daily. The deposit is estimated to be 100 to 118 feet in depth.

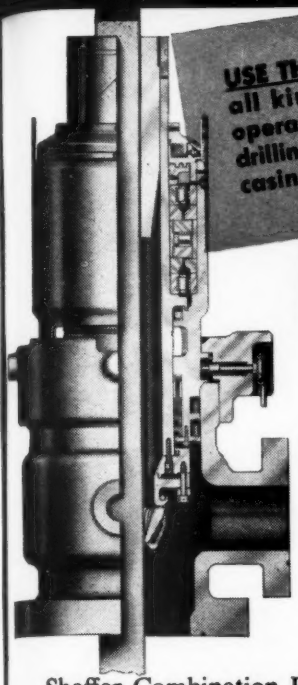
The sand lies under 3 to 14 feet of topsoil an drock, making shaft mining unnecessary. After it has been exposed, it will be mined hydraulically in a process similar to gold placed mining.

The solution of sand and water will be pumped by pipe into the processing plant where the sand will be washed, screened and graded as to size. It will be stored in four 500 ton bins before being shipped.

Silica Sand Corporation expects the oil industry initially will provide more than half the market for its sand. At present about 80 per cent of the nation's high grade silica sand is mined at Ottawa, Illinois.

Oil Costs

More than four and a half billion dollars was spent by the oil industry in the United States during 1944 to expand and develop its resources and facilities. The amount spent for domestic needs was four times that spent abroad.



USE THE TYPE 50 for all kinds of drilling operations, including drilling through 10¾" casing and larger.

BIG JOBS

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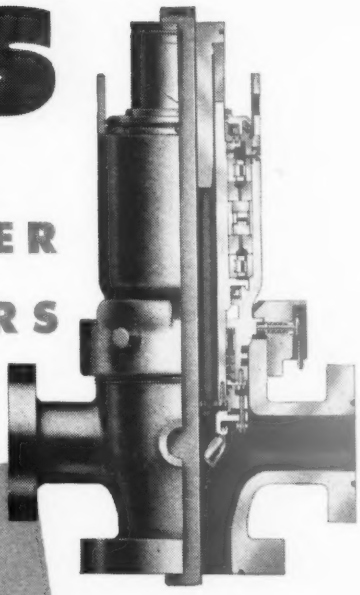


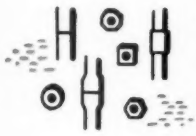
Shaffer Combination Rotating Blowout Preventers and Strippers are recognized throughout the oil industry for their automatic protection against pressure emergencies. And now that this equipment is available in two basic types, every job—whether heavy-duty drilling or light production and work-over operations—can have the unsurpassed protection these Shaffer units provide. Check over these advantages found in both Type 50 and Type 51 units . . .

USE THE TYPE 51 for slim hole drilling, drilling-in, re-work operations, production jobs, and similar applications.

CONTINUOUS SEAL

As long as the drill string is in the hole, a pressure-tight seal is maintained continuously and automatically. There is no need for applying mechanical or hydraulic pressure from the outside — there's nothing to remember or forget — and the seal automatically adjusts itself to the varying shapes and diameters in the drill string. The operator can drill under pressure, and can also strip pipe in and out of the well under pressure — all without adjustments or changes in the unit!

SEALS VARYING DIAMETERS AND SHAPES

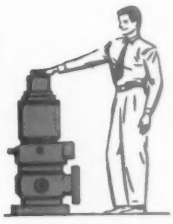


In both units, the Stripper Rubber expands and contracts automatically to fit the varying diameters and shapes of the drill string (excepting such abnormally large diameters as bits and reamers). It seals around any shape — round, square, hexagonal or octagonal — and varying diameters of pipe, couplings, drill collars, subs, etc. No manual adjustment is necessary!

STEEL PROTECTED STRIPPER RUBBER

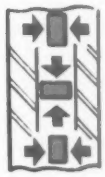
A patented expandable barrier of hinged steel latches prevents the Stripper Rubber from extruding — either by high pressure or by pulling large diameters through it. Yet flexibility of the rubber is assured.

EXTREMELY COMPACT



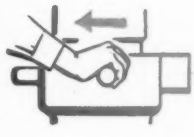
Both units are amazingly compact and can be installed under difficult space limitations. Not only are vertical and horizontal dimensions kept to the minimum, but even the flow connections are built directly into the body, simplifying hookups and eliminating need for spools or similar equipment.

LONG, TROUBLE-FREE LIFE



The Stripper Assembly rotates freely with the kelly — not one inside the other. Thus, there is virtually no wear on the rubber, assuring negligible maintenance and maximum safety. The bearing assembly upon which the unit rotates has separate thrust and radial bearings to withstand a combination of loads due to high pressure and high speed drilling — and bearings are prepacked with a high temperature and high speed stabilized grease.

LARGE DIAMETERS EASILY PASSED



Unusually large-diameter tools such as bits and reamers can be passed through the unit with maximum ease, safety and simplicity by merely pulling a spring latch and rotating the bonnet 1/6th turn, whereupon the entire internal mechanism can be withdrawn as a unit to permit passing the bit or reamer.

Many other advantages **are built into these units. Get full particulars from your nearest Shaffer representative — or write direct!**

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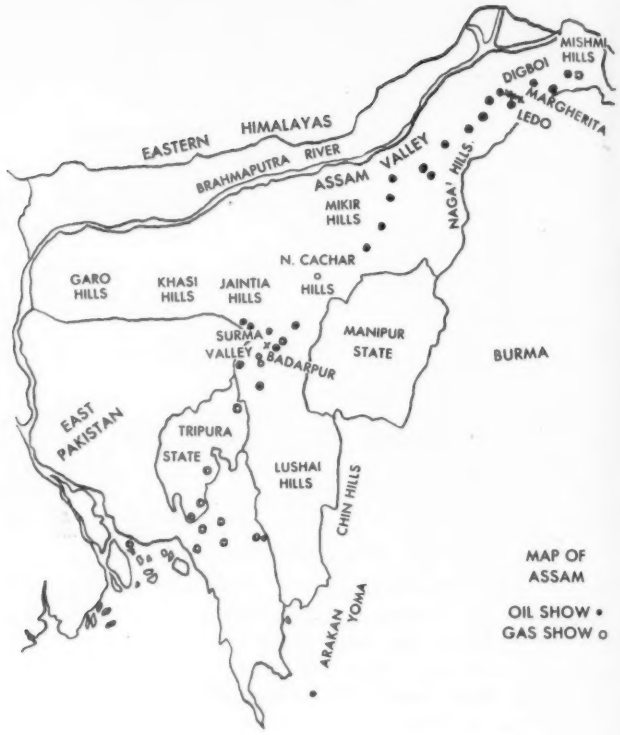

Petroleum Resources

M. K. Indra

NEW and independent India has only one oil field. This is the Digboi field in Assam, which is located near the northeastern border.

India was partitioned into two separate independent countries, India and Pakistan, by the British government before its withdrawal in August, 1947. The oil and gas fields of Punjab and northwestern India now belong to Pakistan. Digboi is the oldest field of Asia and one of the oldest in the world. The Assam Oil Company, a fully owned subsidiary of the British-owned Burmah Oil Company, operates this field.

The history of the discovery of the fields of Assam and their development is quite interesting. The territory of India comprising the state of Assam was annexed to British India in the year 1825. Immediately afterward, British explorers went to that part of the country in search of natural resources. In northeast Assam they found coal and noticed numerous oil and gas springs. But petroleum did not immediately interest those early explorers. Experimental boring for petroleum was first started in the mid-sixties of the last century. The first producing well drilled was at Makum near Margherita in the year 1867. Several successful wells were completed there and a small refinery also was constructed.

A number of factors created a lull in petroleum activity, chief among them being the lack of demand for petroleum products in that locality except for a small amount of kerosine, and the absence of any communication through the dense tropical forests and rough terrain of upper Assam.

The Assam Railway and Trading Company which was working the coal quarries of upper Assam, was forced to construct a railway from Dibrugarh to Ledo in 1882. In course of this construction its workmen once camped near Digboi. An elephant belonging to that party went to quench his thirst in a nearby stream and returned to the camp with feet soaked with crude. This, in short, is the story of the discovery of the Digboi field.

Digboi Field

The Assam Railway and Trading Company began drilling its No. 1 well in Digboi in the year 1889 and formed the Assam Oil Company. Despite strenuous efforts for 30 years this company could not establish itself as a profit-earning oil enterprise. The geology of the area was not known and difficulties were encountered in drilling through hard formations. In 1923 the Burmah Oil Company took over the Assam Oil Company, brought powerful machinery and began a systematic geological study. Production gradually increased and in 1946 reached the steady and high figure of 5000 bbl a day.

The area of Assam is divided into two valleys, the Upper Assam Valley in the north and the Surma Valley in the south with the Shillong Plateau and the North Cachar Hills forming the natural barrier. Numerous oil and gas shows exist along the entire length of the 800-mile stretch of tertiary belt on the western flank of the Arakan Yoma-Naga-Chin Hills range of mountains. This belt, starting from Digboi in the north, passes through eastern Assam, Tripura state, East Bengal, and terminates in the Arakan region of Burma.

The stratigraphy of the tertiary rocks of Assam is complex. The present knowledge of the geology of Assam is mainly due to the work of the Burmah

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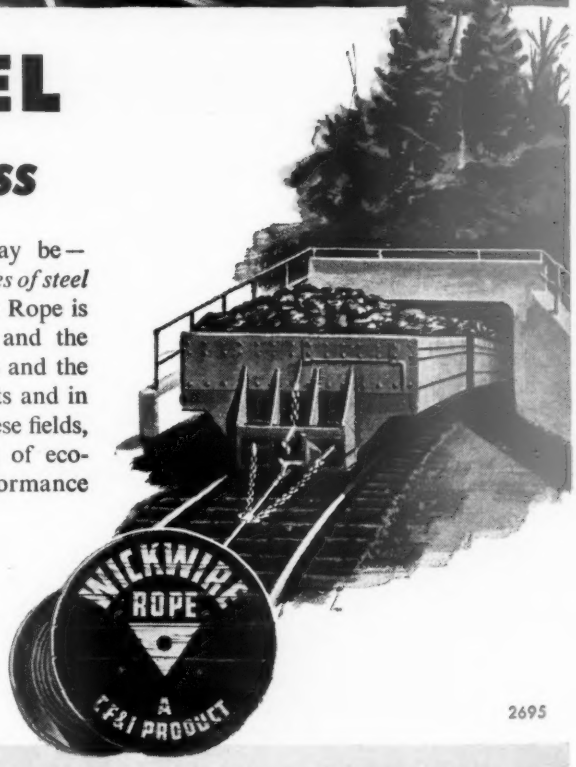

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Oil Company's geological staff. Oil in commercial quantities so far has been found only at two places in Assam, Digboi in Upper Assam and Badarpur in Surma Valley.

The Digboi oil field is on a long, narrow, asymmetric, anticlinal structure which is sharply folded. The northern flank, which is the steeper, is faulted. The structure extends approximately along east-northeast and west-southwest and is bound on the north by the Naga Thrust. The petroliferous rocks range from Middle Miocene to Upper Eocene in age. Oil and gas occur mainly in the sands belonging to the Tipam Sandstone Stage.

In the eastern part of the field production has been obtained from a thin development of the Surma Series. The producing sands of the Tipam Sandstone Stage have been classified into three distinct groups—the Bappapung Sandstone, the Nahor Sands, and the Digboi Oil Sands group. Each of the first two groups consists of five different sands and the third contains twelve.

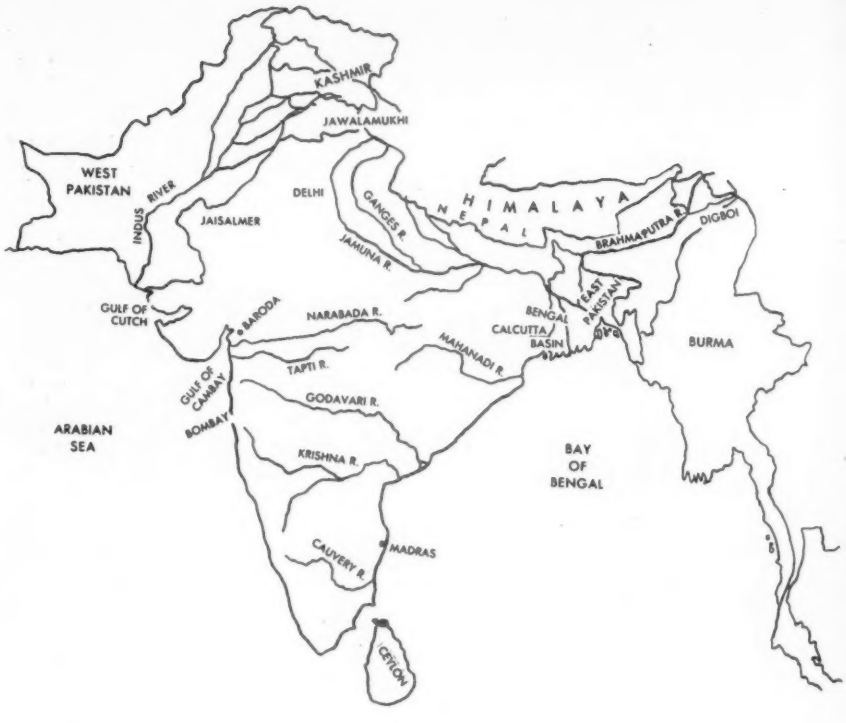
The underground rocks of Digboi are generally conspicuous by the absence of any microforum. The depths of the producing formations range from a few hundred to about 5000 ft. So far, about 950 wells have been drilled in the Digboi area.

The approximate average porosities of the three groups of sands are: Bappapung, 16 per cent; Nahor, 10 per cent, and the Digboi Oil Sands group, 11 per cent. The average gas permeabilities of the individual sands vary between 10 and 150 md. As a group, the Digboi Oil Sands is the least permeable with an average value of about 15 md. The salinity of the formation waters is rather low, varying from 3500 to 7500 ppm from sand to sand.

The reservoir pressure varies between wide limits from place to place, ranging from a few hundred to almost 2000 psi. Tremendous gas pressure is encountered in certain areas. Gas production is controlled and reservoir pressure is maintained by gas recycling. Digboi field is essentially a solution gas drive field. The presence of an expanding gas cap at the crest of the anticline is suspected. In some parts of the field, especially in the eastern extension, water drive is probably the predominant driving process.

Digboi crude is of mixed paraffin and asphalt base. Considerable variation in the composition is observed in crudes obtained from different sands. Crude oils collected from various sources in Assam show even wider variations. Digboi crude is free from sulfur or sulfur compounds. The specific gravities of the oils usually vary between 0.82 and 0.88. Digboi crude is well-known for its high paraffin wax content. It yields at least 15 per cent of high grade solid paraffin. No wonder paraffination is a standing problem in the field. The pour point of the oil is roughly 95 F. The oil yields about 23 per cent gasoline.

The crude is processed locally. The refinery had a daily capacity of 5000 bbl. It is being increased to 7500 bbl per day as a result of the extra production from Nahorkatiya. A gasoline and a lubricating oil plant are recent additions to the refinery. Other facilities include both atmospheric and vacuum distillation towers, Dubbs thermal cracking unit, Edeleanu deasphalting plant, wax purification and molding plant, and a drum-making plant.



Geology of Assam

Much time and attention have been devoted to the geology of the oil-bearing rocks of Assam. Similar time has not been given to collecting information on the characteristics and performance of the reservoir rocks and the properties of the contained fluids, which are essential for the maximum exploitation of the reserves. Mention has already been made that the Digboi field is essentially a depletion drive or solution gas drive field. Admittedly this is not a very efficient process of oil recovery. The relatively high viscosity of the oil is likely to make the situation even worse. As Digboi is India's only oil reserve, it is highly desirable that every effort be made to recover as much of the oil as possible.

Badarpur Field

The Badarpur field in the Surma Valley was opened in 1915. It had a flat-arched, asymmetric, anticline structure stretching along almost north-south. The field was depleted rather quickly and was abandoned in 1933. Altogether about 60 wells were drilled. The water-oil ratio was high. The specific gravity of the oil was sometimes as high as 0.99. The oil had peculiar characteristics. It had an odor of camphor, yielded distillate resembling turpentine, and left a stocky glue-like residue.

Exploration in Assam

Despite continued search for additional sources of petroleum in the tertiary beds of Assam and east India by the Burmah Oil Company, its efforts so

The Author

M. K. Indra is an exchange visitor from India. Educated at the University of Calcutta he received his MS degree in chemistry in 1938. For five years he was a research worker at the University College of Science, Calcutta, in a program of research on oil field problems. In 1944 he joined the Burmah Oil Company as a chemist in its newly created development research laboratory and worked with them for eight years. He received his PhD degree in physical chemistry from the University of Calcutta in 1950. For his doctorate he specialized in surface and colloid chemistry and the chemistry of clays.

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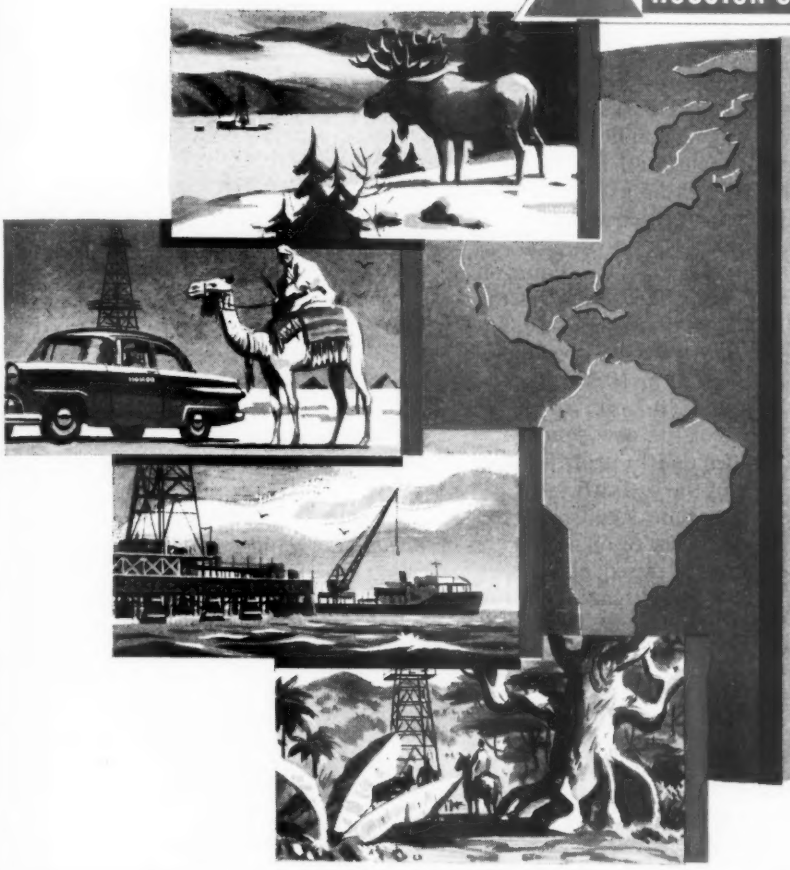

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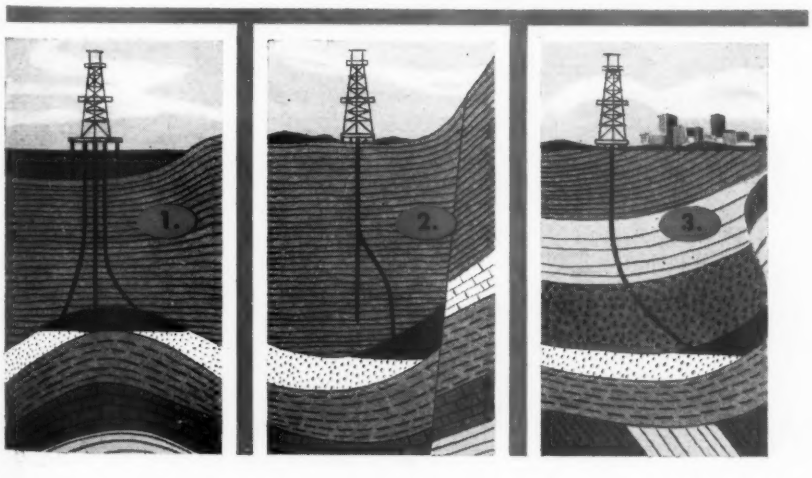

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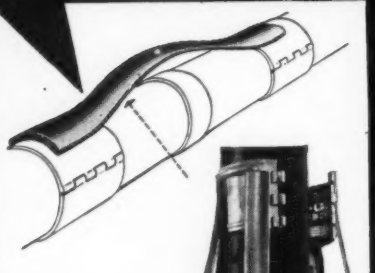

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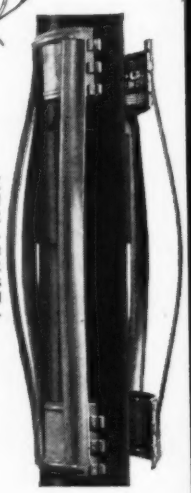

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far have not been very successful. In 1953 oil was found at Nahorkatiya, 18 miles southwest of the main Digboi field. In the past, test wells were drilled at Masimpur and Patharia Hills Forests in the Surma Valley, at Makum-Namdang, Tiru Hills, Barsilla, and Nichuguard in the Upper Assam Valley, and at a number of places that are now in East Pakistan. Masimpur's structure was considered to be highly favorable for oil accumulation. Prospecting and exploration were continued for about 20 years. A number of test wells were drilled. Considerable drilling trouble was encountered mainly from heaving shales and hard formations. Eventually drilling was stopped in 1933 and has not been resumed.

The only discovery in 30 years is the deposit at Nahorkatiya. Four oil bearing sands have been found in the Barails at a depth of 9700 to 10,200 ft. Four successive wells are producing. The fifth one, drilled to 10,945 ft, produced only water. In order to determine the extent of the new source the company has decided to drill the next well northwest of the first two.

The most important significance attached to the discovery of oil at Nahorkatiya is that it has raised new hopes about the probable existence of more oil under the alluvium of the Brahmaputra Valley. An intensive exploration program has been launched by the Assam Oil Company in this area. Modern methods of prospecting are being employed in search of more oil within almost 5000 square miles of the alluvial plain between Mishmi Hills in the northeastern extremity and the Mikir Hills in the southwest.

Potential Sources in India

The Bengal Basin: There are several tertiary sedimentary tracts within the extrapeninsular region of India that are now considered to be potential areas for the finding of oil. The most important is the Bengal basin. Intensive geophysical prospecting by Stanvac of America is now underway within an area of 10,000 square miles of West Bengal. Earlier, in 1951-52, the same company made aerial magnetometer surveys in both East and West Bengals over an area of 73,000 square miles.

The Himalayan Piedmont: The Himalayan foothills in northern India, especially the Jawalamukhi area in East Punjab, is another potential oil source. Geologists, however, contend that the depositional history and the structural disturbances undergone by the sub-Himalayan ranges are against the possibility of the accumulation of oil in large quantities.

The Gulfs of Cambay and Cutch: Although the visible structure along the shoreline of Saurashtra does not bear much evidence to support the existence of oilbearing rocks underneath, the possibility of petroliferous rocks being present under the ocean beds of the Gulf of Cambay is not altogether excluded. Natural gas is often found in Baroda and Gogha in the northern part of Bombay state. The rocks under the alluvium of northwest Gujerat part of Bombay have not been tested for oil.

Central Rajputana: The deserts of Rajputana have attracted attention in recent years as a probable source of petroleum. Jaisalmer has been selected for immediate prospecting by geophysical methods.

Future Hopes

When the new refineries of India begin operating at full capacity, the products manufactured will supply about 60 per cent of India's requirements of gasoline and about 50 per cent of kerosine. These refineries will have to depend entirely on crudes from outside the country. In order to make India self-sufficient in petroleum, the finding of new sources within her boundaries is very urgent. Fortunately, the national government is fully conscious of this. Systematic geological mapping for locating the potential sources of the mineral wealths of India had not been undertaken in the past. The Indian government has decided to go ahead with this project as part program of the current Five Year Plan. Top priority has been assigned to geophysical prospecting for oil in Jaisalmer in Rajasthan and the Jawalamukhi area in East Punjab.

The government's desire to help develop the petroleum industry is further reflected by the fact that in the exploration work in Bengal Basin by Stanvac the central government will bear 25 per cent of the expenses up to $5,250,000. It has also invited the Assam Oil Company and Caltex to work in the remaining area of the Bengal Basin.

Although the petroleum industry in India started a long time ago, it has not yet developed into an important one. More than one factor may be responsible for this state of affairs. The open secret of the tremendous advancement of the petroleum industry in the United States is competition. Probably the main reason for India lagging far behind is the lack of practically any competition in the past. It is a hopeful sign that American companies with their vast experiences are appearing on the Indian scene. India needs to share her experiences to develop her oil industry in all its phases. It is hoped that cooperation will be extended in every possible way to the mutual benefit of both America and India, furthering the friendly relations between these two great nations. * * *

DRILLING PRACTICES IN THE PERMIAN BASIN

R. J. Bromell

Keen competition has brought about a united effort on the part of contractors and oil operators to solve mutual problems. Everything from equipment through drilling practices has been studied and discussed at API and AAODC meetings in an effort to enlighten personnel. Equipment is matched to the job with greater care, new practices and techniques are studied and evaluated, and new approaches to old problems are systematically tried and analyzed. Operational personnel are enlisting the aid of technical personnel and results are evident in the remarkable improvement made throughout the Permian Basin.

IN September, 1951, there were 720 rotary rigs operating in the Permian Basin. A drastic reduction in the number of active rigs was brought about by a steel shortage and curtailment of Spraberry development programs. By August, 1952, the number of active rigs had dropped to 439. With so many rigs available for normal exploration and development, footage prices began to fall. Lower prices and continued competition brought about many changes. A new interest in means of solving mutual problems arose in local API and AAODC meetings as members were no longer content with relying on their then current methods.

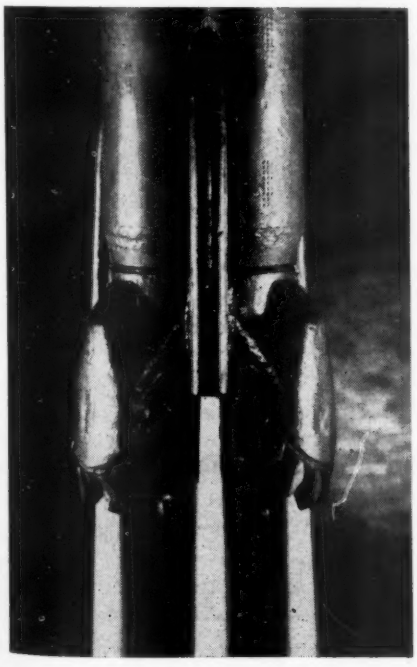
The API committee meetings are open to all persons interested in drilling. Problems pertaining to all phases of drilling are discussed, with special emphasis given to those of mutual concern such as lost circulation, crooked hole, and jet-bit performance. Equipment manufacturers, service companies, suppliers, and experts in various fields have brought new light to old problems and, as a result, progress has been made along numerous lines.

Some of the progress made, however, would not have been possible without cooperation from the oil operators. Ultimately, the operators benefit by improved practices through more hole for their money; but aside from the monetary gain, better relations have been established through mutual investigation of problems. The effect of jointly studying problems has been reflected in relaxation of certain contract clauses.

Future savings for both contractor and operator will result from exchange of information and continued joint study of problems.

Presented by R. J. Bromell on behalf of the Central West Texas section, Southwestern district committee on Drilling Practices, American Petroleum Institute.

FIG. 1. Indexing sub to alternate flow through jets or conventional nozzles



Bit Weights

Bit weights have increased greatly during the past two years. Normal practice of carrying 30,000 to 40,000 lb on 12¼-in. bits has increased to 70,000 to 110,000 lb, while 8¾-in. bits are carrying 50,000 to 80,000 lb instead of the 30,000 to 45,000 lb of two years ago. Some contractors are carrying 70,000 lb on 7⅞-in. bits and 50,000 lb on 6¾-in. bits. This is not considered a general practice as yet. Average weights in 7⅞-in. hole are from 35,000 to 50,000 lb and in 6¾-in. hole, 30,000 to 35,000 lb.

Increased weight on the 12¼-in. bits is due largely to the jet bit. Without the aid of jet bits a great deal of the benefit derived by increased weight in the softer formations would be impossible.

Many problems aggravated by increased weight have become topics for study by various groups. Among those considered most important are:

1. Crooked hole;
2. Drill collar cost and maintenance; and
3. Bit life as related to weight and rotary revolutions per minute.

All of the foregoing problems are now much less formidable than they were two years ago.

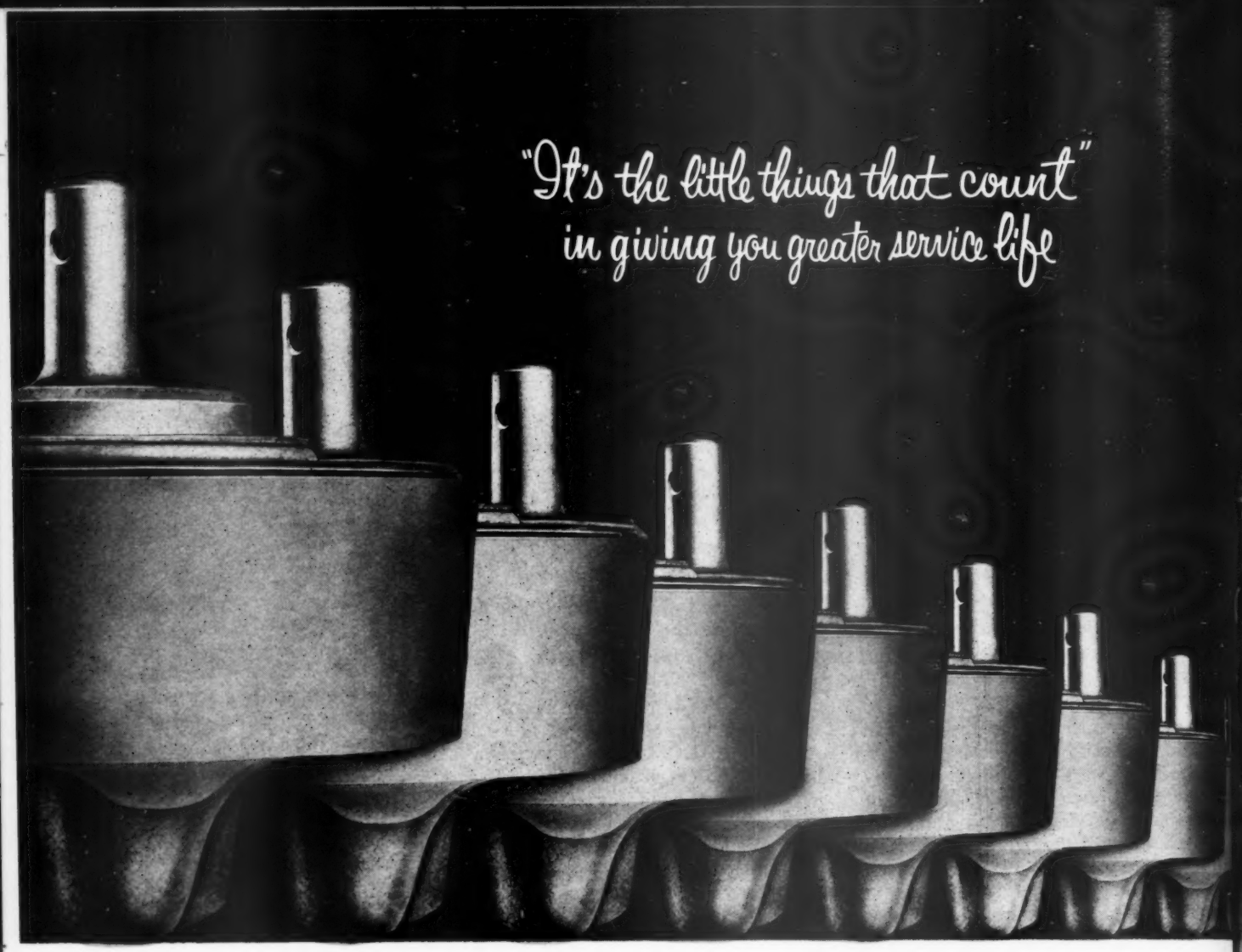
Drill Collars

The changes in drill collar practice in the last two years are not really changes—but rather are a widespread acceptance of practices considered experimental two years ago.

In drilling 8¾-in. hole, 6¼-in. OD collars were the usually accepted drill collar size two years ago. Frequently collars worn to as small as 5¾-in. OD were used. Now, 7-in. OD or 6¾-in. OD collars are the usual size of collars in 8¾-in. hole. Overshot fishing tools and wash pipe are available for conventional washover and fishing procedures for retrieving 7-in. collars in 8¾-in. hole.

A few companies were drilling with

FIG. 2. Special joint designed for threaded and coupled drill pipe



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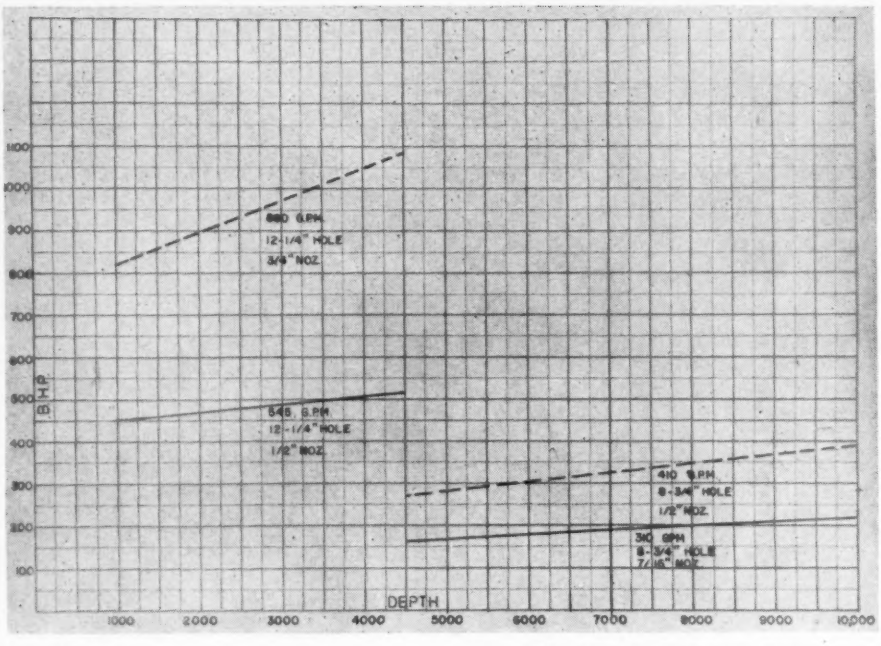


FIG. 3. Comparison of horsepower required for high annulus velocity and low annulus velocity.

FIG. 4. Bottom drill collar melted by fire in producing zone air drilling.

8-in. collars in 8¾-in. hole as a means of combatting crooked hole two years ago. Because these collars were not retrievable by conventional washover procedure, they were termed "oversize collars." The use of oversize collars, 7-in. in 7⅞-in. hole and 8-in. in 8¾-in. hole, has become quite common. Frequently only one, two, or three of these collars are used below a conventional string, but a number of companies have now run full strings on many wells. Operational success has been considerable, not only in minimizing the severity of crooked-hole zones, but also in improved bit performance. One operator reports that the use of a full string of 7¾-in. collars in 8¾-in. hole consistently resulted in greater footage per bit in considerably less hours than on an offset location drilled at the same indicated weight with 6-in. collars in 8¾-in. hole. Others have reported a similar trend. Apparently the larger collars minimize the loss of weight caused by buckling of the collar string against the wall of the hole and maintain uniform loading of the bit. It has been demonstrated that using small collars above the bit results in bending of the bottom collar with a corresponding "walking" of the bit, alternately loading one cutter at a time. This walking of the bit produces accelerated bit wear and bearing damage, and loss of the efficiency of cutting action of the bit.

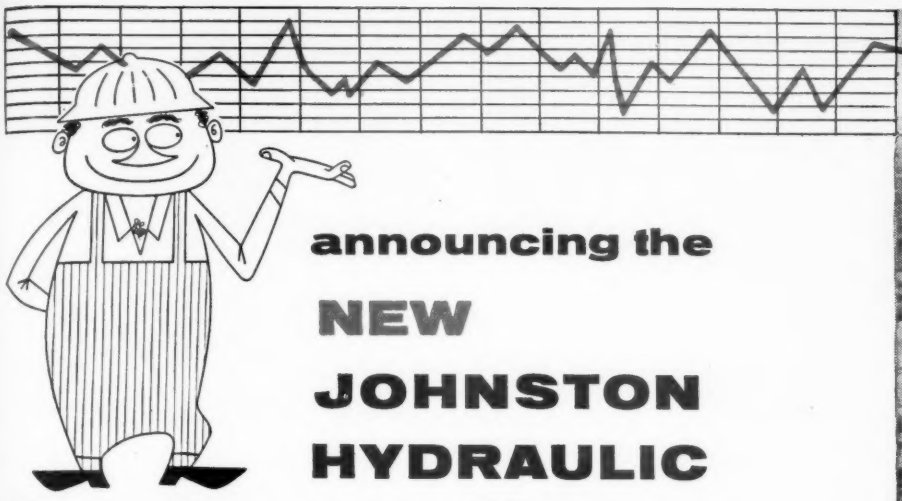
The expected loss of many strings of oversize collars and junked holes has not materialized. Eight-inch collars have been successfully retrieved from 8¾-in. hole by taper tap on many occasions. On at least 3 occasions, 7-in. collars have been washed over in 7⅞-in. hole by use of flush-joint 7⅝-in. wash pipe. A string of specially prepared wash pipe is available for washing over 8-in. collars in 8¾-in. hole. There is much less risk involved than was generally anticipated, and more general use of oversize collars is expected.

Two years ago, L. E. Trishman of The National Supply Company reported at the API Southwestern district spring meeting on full-scale laboratory fatigue of drill collar joints with stress-relief grooves. Comment at the meeting indicated that field tests of similar joints had confirmed the advantages shown in the laboratory. An API standardization committee studying drill collar joint performance has conducted controlled field tests on joints that incorporated such stress-relief features. These tests also have indicated that these features have improved the life of drill collar joints.

In the Permian Basin area today, many rig operators are using stress-relief features in all drill collar joints; even more of them are using these features to combat excessive box failures as the outside diameter of the collars wears down and the critical section of the box becomes thin. In areas where the unengaged threads at the bottom of the box accelerate failure, stress-relief features at this point will minimize the corrosion-fatigue problem by removing the stress-concentration effect of these threads.

One notable change in drill collar practice in the Permian Basin is related to the increased bit weight now being used. This naturally implies a need for more drill collars or larger drill collars, or both. Two years ago, eighteen to twenty 6¼-in. OD drill collars were the average string run in 7⅞-in. hole. Now it is common to see 20 to 25 such collars in a string; and, on occasion, some strings of 30 or more 6¼-in. collars have been run in 7⅞-in. hole. The change to 7-in. OD collars in 8¾-in. hole has increased weight without increasing the number of collars in the string; but even here, more than 20 collars are sometimes used.

The loss of drill collar weight and the weakening of the drill collar joint box as the drill collar diameter is reduced by wear have prompted the use of hard-facing materials to retard outside-diameter wear. Records indicate that, in the Permian Basin area, collars in continuous use may be expected to lose ¼-in. of diameter per year. Appli-



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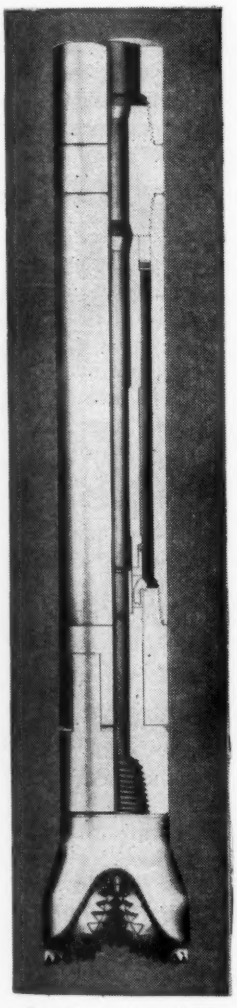

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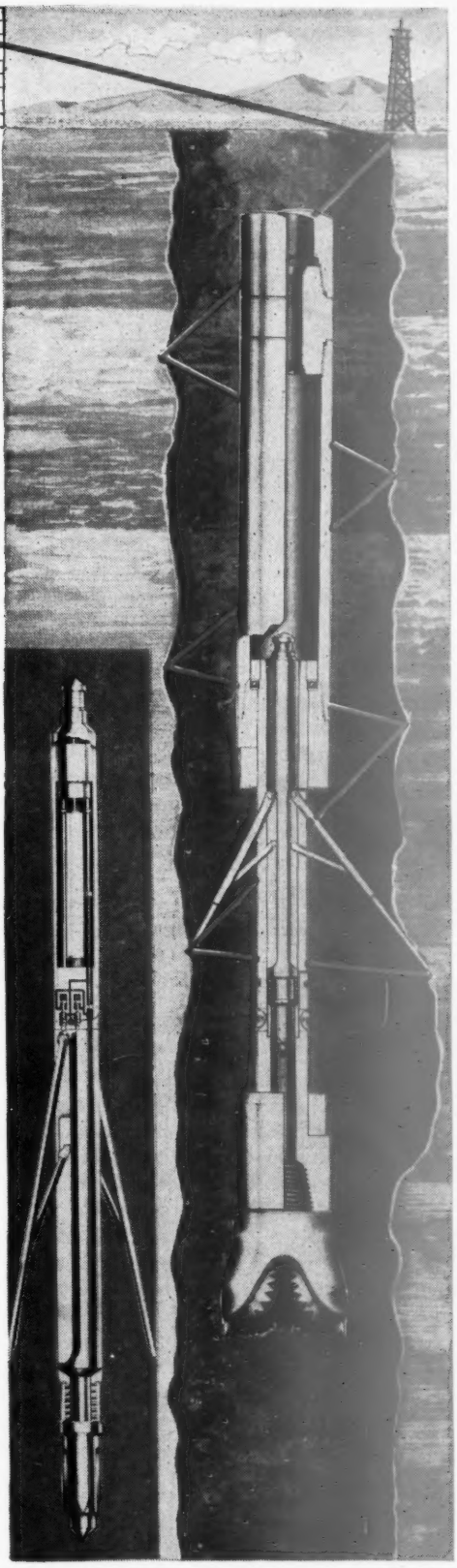

This is the Caliper Instrument with cutaway view of the hydraulic system, clock and chart compartment.

Receiving sub is open and Caliper in measuring position. Caliper instrument unlocks sub as it is indexed in place.

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FIG. 5. Air compressor units used in air drilling operations.

cation of a 10-in. band of tungsten carbide hard-facing material about 20 in. above the pin shoulder has been surprisingly effective in retarding wear. Where drill collars have been lengthened by welding on stubs of larger diameter than the body of the collar, it is essential to protect the stubs with a wide band of hard-facing material, or they will soon be worn to the same diameter as the remainder of the string.

Chert Bits

It was formerly believed that chert bits should be used in areas having a minimum of 20 to 30 per cent chert, or at least should not be used if a conventional hard-formation bit would make 25 ft. Chert bits are now replacing conventional bits in hard limestones and dolomites, especially when there are no inter-bedded shale streaks. Table 1 illustrates what improvement can be made through the use of chert bits.

TABLE 1.

	All regular bits	Chert bits and 1 regular bit
Interval, ft	6758–8013	6811–8053
Footage	1255	1242
Total bits	22	5
Rotating hours	170¾	182
Cost per ft	$12.69	$10.92

Table 1 is based on $40 per hour rig cost and includes rotating hours, trip time, and bit cost. Such marked improvements are not to be expected when drilling with mud. The exact difference between using chert bits in clear water and in mud has not been fixed, but results indicate that it is considerable. This problem is currently being given special study.

Jet Bits

Still a highly controversial subject is the merit of the jet bit. Among the users of jet bits, the proper methods of application are even more controversial.

Annulus velocities in the magnitude of 180 ft per min are no longer believed by most operators to be necessary to efficient jet drilling. Very successful operations while drilling in the red beds have been conducted with annulus velocities of 100-ft to 110-ft per min. This was done with 530 gpm to 560 gpm, ½-in. nozzles, and 5½-in. OD drill pipe is compared to previous concepts of 880 gpm and ¾-in. nozzles. Horsepower to get comparable results was 567 less at pipe point.

Many operators use jet bits and enlarged nozzles to relieve pumps and engines with no regard for nozzle velocity, bit horsepower, impact force, or annulus velocity, and yet believe that jet bits pay off. Still other operators do not run jet at all because they believe that the return is not justified by the additional cost. Both cases are justified in their respective places and until the entire drilling operation is meticulously analyzed and reliable answers given, some operators will continue to reap greater dividends with jet bits while others do the same with conventional.

Tests are being conducted to carefully evaluate jet-bit performance.

It may be necessary to completely change jetting practices to coincide with drilling practices. An example would be that once a relationship is established between penetration rate and nozzle velocity at a given weight and rotary speed, such relationship might not hold true if either the weight or rotary speed change. The wide diversity of opinions on effectiveness of jet bits may well be the effect of different drilling practices. It is believed that, once the basic questions are answered in the field tests, a method will be made available whereby the degree of improvement for specified conditions can be accurately determined.

What relationship actually exists between penetration rate, bit horsepower, weight, rotary annulus velocity, nozzle velocity, rotary speed, depth, and mud characteristics is indeed evasive, but must be determined. In the future we may find that crooked hole, forcing light weight in hard formations, the mud characteristics, and even the hydrostatic head on formations will be the basis for deciding if premium-priced jet bits should be used. This premium is a small amount; but when over 100 bits per well are used, the total figure is significant. What is more important about a study of this type is that once enough information is available to evaluate correctly the conditions favorable for jet bits, we will uncover many of our basic problems of penetration and through this understanding will greatly improve drilling practices.

An indexing sub, Fig. 1, is being used to alternate fluid flow through conventional water courses and jet water courses. A comparison can be made in the penetration rate of alternate intervals. This tool can also be used to change size of jets while drilling; and, in this way, relations can be established among the many variables of jetting.

Drill Pipe

Jet bits have been responsible for many contractors changing to larger drill pipe. The once very popular 3½-in. OD pipe has given way to 4-in. OD and 4½-in. OD pipe. Intermediate holes of 11-in. or 12¼-in. are being drilled with 5½-in. pipe more frequently now than several years ago.

At first glance one might be skeptical about some of the present-day trends toward larger pipe, since it seems we are reverting to old practices. More contractors are aware of the hydraulic advantages of the larger drill pipe and prefer using it, despite the extra weight of hoisting and higher initial cost of the pipe.

Although drill collars are the principal source of weight, some pipe weight is still used by the contractor especially when using 5½-in. OD pipe. This practice cannot be entirely criticized since the large demand for drill collars and the need for weight can often justify using some pipe weight when using 5½-in. OD pipe.

Cost-conscious contractors and operators are looking over old discarded practices to re-evaluate them in the light of today's thinking. One of the significant "finds" from the past was actually stimulated by work done in California and examination of a war-imposed experiment designed to conserve time and material. Tests are currently in progress and others are proposed to exploit the practicability of threaded-and-coupled drill pipe, viz., drill pipe with couplings instead of tool joints. (Fig. 2) On wells of medium

depth, 5000 ft to 6000 ft, one string of 4½-in. OD Grade D drill pipe with couplings drilled 152,000 ft and a second is still in use after 95,000 ft of hole.

Improved metallurgy may make it possible to extend this same type service to deeper wells with smaller rigs by using thin-walled pipe with higher strengths than present drill pipe. Although this type drilling has been going on for some time in California, it has been slow to start in the Permian Basin, perhaps because of the severe pipe-wear conditions prevalent throughout the Basin.

One major company is evaluating the use of drill tubing and casing it has found successful in California. Based on the findings of those using the tubing in California, a special connection was designed to overcome its major disadvantages. After drilling 21,000 ft of hole with pipe having this special thread, it is believed that the major objections have been overcome.

The joints are easy to stab, have rapid make-up and breakout, and show very little tendency to make up while drilling.

Slower rotary speeds, education of personnel, use of power tongs, and economic incentive may all help to make thin-walled drill pipe with couplings a practical tool in the hard rock country.

Pumps

Jet bits have done more to point out the lack of adequate knowledge of pump and rig horsepower requirements than any one item. Everything from large-horsepower pumps and small engines to small-horsepower pumps and large engines could be found. A rig balanced as to drawworks, pump, and engine horsepower was the exception. What actually confused and still confuses most contractors is the in vague understanding of what is really required.

The first tendency was to buy large pumps and larger engines. Results presented by rigs boasting 1800 to 2000 maximum horsepower and pumps from 600 to 850 hp were quite impressive until small rigs began to compete with and, in some cases, surpass performance of the big rigs.

Obviously, other factors such as personnel, weight on bit, rotary speed, mud, bit types, and many other variables entered into the picture and to this day it is impossible to evaluate the effectiveness of each.

For West Texas—New Mexico, it is gradually being accepted that the need for large pumps, 600 to 800 hp is limited and that better flexibility and lower drilling costs can be had with pumps in the 300 to 500 hp class. The smaller pumps are used for jetting in small holes on 5000-ft to 7000-ft rigs, and the larger pumps used in parallel on large intermediate holes then singly on production string holes of deeper wells.

Series compounding of pumps has been done to a limited extent. The parallel application of pumps has been more generally accepted as a means of meeting hydraulic needs. Fig. 3 illustrates the horsepower required for jet drilling as originally believed necessary and horsepower used on tests to check feasibility of increasing bit horsepower and reducing annulus velocities to values formerly believed impractical. From this illustration it is apparent that larger-horsepower pumps cannot be justified conclusively for the type drilling found in West Texas and New Mexico.

Air and Gas Drilling

The practice of using air or gas as a drilling medium was been used to some extent in the Permian Basin. Results obtained through the use of gaseous drilling fluids have been much the same as those obtained in other areas. Water-bearing formations are the major source of trouble, too much water makes it impractical to air lift, and very small amounts of water permit packing of cuttings on drill pipe and hole walls. The latter often results in stuck pipe.

Opinions on what is needed to drill properly with air or gas vary widely. Some operators think 1,500,000 cu ft per day at 120 psi is sufficient, whereas others are of the opinion that 3,500,000 cu ft per day at 1200 to 1500 psi will be needed. Obviously, the wide divergence of opinion is due to the varied conditions encountered by those who have tried air or gas drilling. The lower volumes and pressures may be sufficient if depths are shallow and there are no water sands to contend with. Introduction of small amounts of water to further moisten cuttings and prevent sticking may require more air volume, and certainly aerating mud columns will require greater pressures. The many ratios of moisture and gaseous fluids between the extremes of mist and aerated muds present numerous and varied problems. What is needed, how much improvement to expect, and the ultimate saving will vary as the ratio varies. Just how to evaluate the problem and establish the best practices promises to be even more controversial than the merits of the jet bit in the Permian Basin.

The following cases are selected from some of the operations conducted throughout the Basin Area.

In the Caprock field of Lea County, New Mexico, three wells have been drilled in with air into the Queens sand. Prior to the first of these, there had been no successful completion drilling in with rotary tools using mud in this immediate area.

The first well drilled in with air was completed as a flowing well. The other two have been dry holes outside the field. On the well which was completed, while drilling into the pay section a fire in the hole was ignited by a piece of burning rubber from the lining of an air hose. The only evidence of the fire at the surface was a puff of white smoke from the flow line. The bottom drill collar became hot enough to melt, however. The fire was extinguished when air circulation was stopped (see Fig. 4).

In another area, southeast of Hobbs, New Mexico, a section of 8¾-in. hole was drilled with air, beginning below the intermediate casing at 3100 ft. Drilling proceeded to approximately 4500-ft where water in the hole forced a return to mud as a drilling fluid.

A comparison of this well with a diagonal offset is shown in Table 2.

TABLE 2.

	Air	Mud
Hole size, inches	8¾	12¼
Footage drilled	1293	1412
Number of bits	2	12
Rotating hours	56¼	231½
Weight per in. of diameter, lb.	1140–2860	2860–4100
Revolutions per minute	65–70	75
Approx. interval drilled, ft.	3100–4400	3100–4500
Vol. circulated, cu ft per day	1,900,000	
Air pressure, psi	60–90	

A 3600-ft well, also in New Mexico, was drilled from under the surface pipe to 3277 ft with air. The first bit drilled from 1185 ft to 2880 ft with an average penetration rate of 60.6 ft per hour. The second bit drilled from 2880 ft to 3277 ft. Drilling rates of 5 ft per min were obtained with 30,000 lb weight, but crooked hole forced weight to 10,000 lb. Average penetration rate for 6 wells in the immediate vicinity of this well was 23.3 ft per hour and bits averaged 632 ft for the interval drilled by the first bit.

Four cores cut from 3277 ft to 3364 ft had 100 per cent recovery. Difficulty was experienced while coring because of fluid entry into the well bore, and practically no cuttings were circulated while coring and reaming the core hole. Coring on the other 6 wells using mud averaged 2.5 ft per hour as compared to 11.4 ft per hour on the well drilled with air. The well was mudded up at 3364 ft and cored to total depth.

Two wells drilled by the same company in Val Verde County, Texas, are compared in Table 3. (See table, page B-62.)

The gas-drilled hole was handicapped by crooked hole as indicated by the light weights. Despite this disadvantage, the results were very impressive.

The interest that has arisen in recent

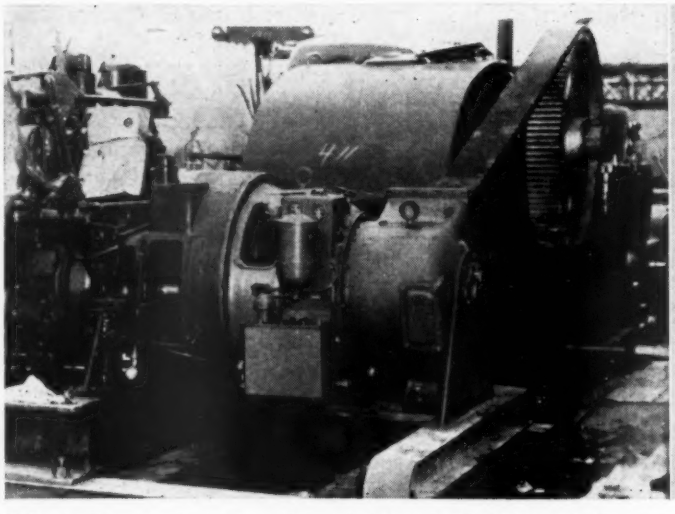

FIG. 6. Torque-converter unit on independently-driven slush pump

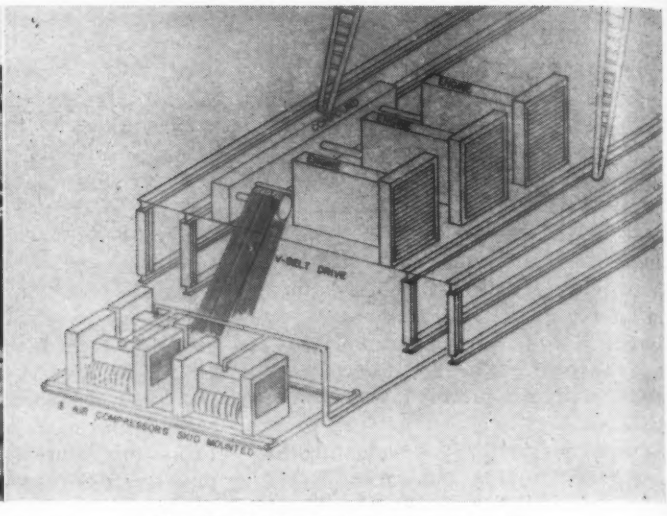

FIG. 7. Sketch of air compressor units

TABLE 3.

	Gas	Mud
Hole size, in.	8¾	8¾
Footage drilled	7251	7263
Number of bits	84	154
Feet per hour	9.25	7.2
Rotating hours	783.5	1008.75
Weight per inch of diameter	250–2000	4500–5700
Revolutions per minute	70	75
Interval drilled, ft	1510–8761	1500–8763
Vol. of gas, cu ft per day	1,500,000	
Gas pressure, psi	75–100	

months in regard to air and gas drilling has prompted compressor manufacturers to alter portable equipment.

Feed Controls

Information on comparison of wells with and without automatic feed controls is limited. One report given by a major company did not find much in favor of the automatic feed controls. However, data compiled by another company showed a marked improvement in the average drilling operations through the use of automatic feed controls.

Information on the operations, which showed an improvement with use of automatic feed controls, has been made available by the Humble Oil & Refining Company. The wells are all located in the same field, drilled by the same rig, and employed the same personnel. With such ideal conditions it would be difficult to find more conclusive information than that presented in Table 4.

Little improvement, as shown in Table 4, resulted in the intermediate hole; but in the interval from approximately 4000 ft to 7000 ft, 16.27 per cent increase in penetration was obtained. Wells completed in the lower Spraberry indicate greater improvement in the penetration rate as total depth of wells increased. An overall average improvement of 11.9 per cent was obtained with the automatic feed control.

TABLE 4. Comparison of penetration rates — feed control.

	Before installation of feed control	After installation of feed control
Surface hole	7 Wells	10 Wells
Average depth, ft	368	361
Avg ft drilled per hr rotating.	29.36	32.16
Avg increase in penetration, per cent		9.53
Intermediate hole	7 wells	10 wells
Avg interval considered, ft	3642	3758
Avg ft drilled per hr rotating.	44.59	45.39
Avg ft drilled per bit	520.3	463.9
Avg increase in penetration, per cent		0.179
Oil-string hole (through Upper Spraberry)	6 wells	10 wells
Avg interval considered, ft	3988–7115 (3127)	4119–7091 (2972)
Avg ft drilled per hr rotating.	17.94	20.86
Avg ft drilled per bit	175.3	199.5
Avg increase in penetration, per cent		16.27
Oil-string hole (Lower Spraberry)	5 wells	3 wells
Avg interval considered, ft	3963–7999 (4036)	4201–8184 (3983)
Avg ft drilled per hr rotating.	15.35	18.35
Avg ft drilled per bit	153.5	151.3
Avg increase in penetration, per cent		19.5

Hydraulic Equipment

As the average depth of drilling increased and power becomes more important, power transmission also becomes more important. In order to obtain some of the better features of steam or electric rigs, many new rigs are being equipped with hydraulic couplings or torque converters. Most significant are:

1. Engines will not stall, thus preventing lugging at high loads;
2. Dampens crankshaft torsional vibrations;
3. Engines can be synchronized within slip range.
4. Shock loads on power trains are materially reduced;
5. Greater flexibility.

Operators report that maintenance on power trains and engines has been materially reduced. One major concern has had a 50 per cent reduction in rig repairs, while another has had 50 per cent reduction in engine maintenance. It is becoming more common to hear reports of compounds running 2 or 3 years without a chain failure.

Auxiliary and independently driven slush pumps are using torque converters and fluid couplings. Fig. 5. Torque-converter equipment units make it possible for the engines to run at or near governed speeds and the pump strokes vary according to the load. Within certain limits, this reduces the number of liner changes. Care must be exercised not to exceed the recommended pinion-shaft torque.

Transfer of power through fluid reduces the shock loads throughout the engines, power train, and pump. Maintenance costs are materially reduced on engines and pumps when unitized in this manner.

The practice of overspeeding power pumps as a means of obtaining greater hydraulic horsepower than the pumps were designed to handle is also greatly enhanced by using hydraulic drives. An example is presented in the use of a 14-in. pump designed for 255 input hp at 65 strokes per minute which, with a flooded suction and fluid couplings, is being used at 90 spm and 350 input hp. The pump has more than 6 months' service at this load with no ill effects.

Hydraulic motors and pumps have become widely used as a means of transmitting and applying power. Shale shakers, water pumps, wire-line reels, blowout preventers, mud mixers, and other equipment are now being operated by hydraulic power. The use of such power offers protection against fire when drilling with gas, and is flexible in its application. Maintenance costs are reportedly low as compared to other types of power.

One application of particular interest to users of hydraulic power transmission is in rotary-table drives. Although

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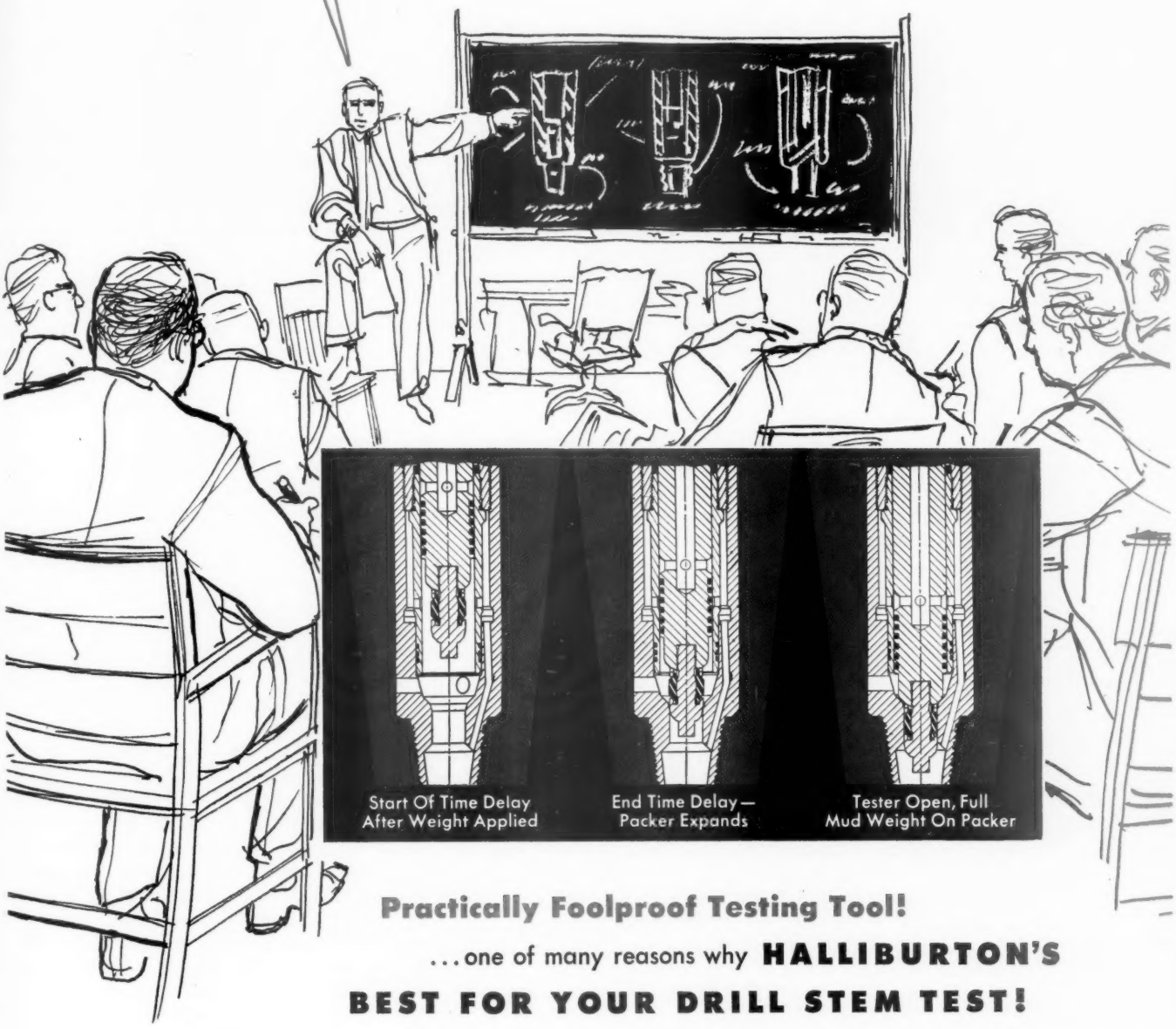

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TABLE 5.

Year	Field	Intermediate hole: Size, in.	Intermediate hole: No. bits	Intermediate hole: Days	Production hole: Size, in.	Production hole: No. bits	Production hole: Days	Total: Bits	Total: Days	Total depth, ft
1952	Townsend	11	20	22	7⅞	98	81	118	103	10,581
1954	Townsend	11	8	12	7⅞	60	37	68	49	10,629
1952	Denton	11	14	14	7⅞	120	84	135	98	12,229
1954	Denton	11	11	11	7⅞	81	57	70	68	12,472
1952	Yarbrough Allen	12¼	6	8	8¾	71	59	77	67	10,719
1954	Yarbrough Allen	12¼	8	10	8¾	69	53	61	63	10,575
1953	Magutex	12¼	14	14	8¾	65	72	79	86	12,570
1954	Magutex	12¼	8	13	8¾	62	62	70	75	12,607
1953	Midland Farms	12¼	16	13	8¾	102	77	118	90	12,654
1954	Midland Farms	12¼	11	12	8¾	63	44	74	56	12,490

limited information is available, it seems that advantages of rotary speed control and predetermined torque on pipe will make this type drive desirable. The extent to which this type drive has been used and developed is still limited to experimentation.

General Comparison 1952-1954

All of the aforementioned developments in Permian Basin practices have had a remarkable composite effect. Table 5 illustrates the change that has come about.

The most interesting fact, aside from the increase itself, is the small difference in the Yarbrough Allen field. Both wells were drilled by Humble Oil & Refining Company and employed similar practices. Humble was using oversize collars and heavy weights with jet bits when the first well was drilled. It is evident that they were one of the first to recognize the advantages of such procedures. This example further illustrates what the oil operators have contributed to better drilling. The drilling contractors are using these ideas and others advocated by the drilling departments of other companies and are preparing to take a more aggressive part in the future developments of drilling technology.

Conclusions

Increased weight on bits to obtain greater penetration has brought about more crooked hole, need for more collars, and greater power to handle the loads. The added power for hoisting has in many cases been applied to jet drilling which also has increased penetration rates. The size of pump needed and the proper way to use jet bits is still controversial, but it is generally conceded that pumps in the 200-to 500-hp class will be sufficient for most West Texas drilling.

A more scientific approach to drilling problems, both in application of equipment on the surface and at the bottom of the hole, has resulted in great improvements in drilling time. Continued cooperation between contractors and oil operators is essential to improved drilling practices, and the free exchange of information both individually and collectively through API and AAODC meetings will bring about the needed improvement.

Air and gas drilling, proper sizing of new equipment, use of light-weight drill tubing, and use of new techniques are bringing about reduced costs. As we enter 1955 the many unanswered questions on proper application of drilling tools offers a challenge and promise that better methods and practices will evolve in Permian Basin drilling.

Acknowledgments

The author is indebted to many persons and companies for information presented in this paper. Special thanks are extended to the following for both their efforts and material which helped in forming this paper: H. M. Rollins, Drilco Oil Tool, Midland, Texas; W. R. Johnston, Humble Oil & Refining Company, Midland, Texas, and L. P. Nell, Great Western Drilling Company, Midland, Texas.

* * *

API Honors Agriculture

A nation-wide program for 1955 to spotlight the nation's outstanding young farmers has been by the Committee on Agriculture of the American Petroleum Institute and the United States Junior Chamber of Commerce.

Details of the program are contained in a statement by R. E. Preston, The Standard Oil Company (Ohio), new chairman of the API agricultural group. Preston also outlined a broad schedule of other activities for his committee.

"Under the co-sponsorship of the Jaycees and API, a country-wide search is being launched for farm operators in the 21-through-35-year age range who have distinguished themselves through use of outstanding agricultural methods, extraordinary success, and contributions to their communities," Preston said.

State selections for young farmer candidates will be made between April 17 and 23 and a national event to honor state winners is planned for June 2 and 3. At the national event, the state winners will participate in a program of tours, meetings, and banquets with special honors to be bestowed upon America's Four Outstanding Young Farmers. The outstanding four will be selected from the state winners by a panel of outstanding agricultural leaders.

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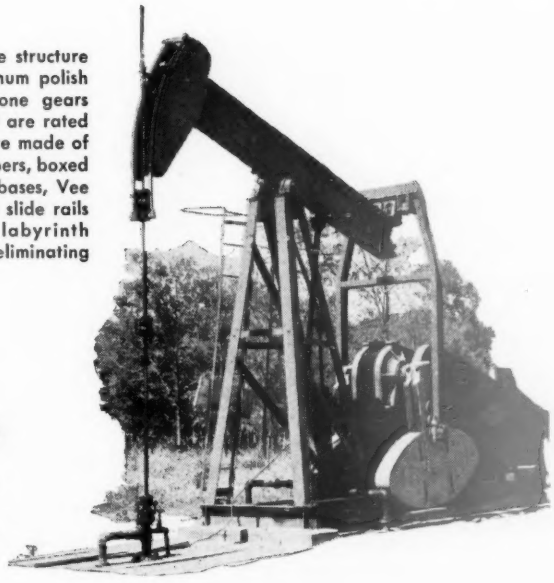
Cabot Type AC (Adjustable Crank) Units have structure capacities from 9,000 to 32,000 pounds maximum polish rod load. Reducers have Sykes-cut herringbone gears rated from 40,000 to 456,000 inch pounds. All are rated to API standards. Derrick-type samson posts are made of heavy angles with well-designed bracing members, boxed in at the top with steel plates. Floor clearing bases, Vee belts, belt guards, reducer oil, and adjustable slide rails are standard equiqment. Oil slingers and labyrinth grooving are used on the reducer shafts eliminating oil seals.



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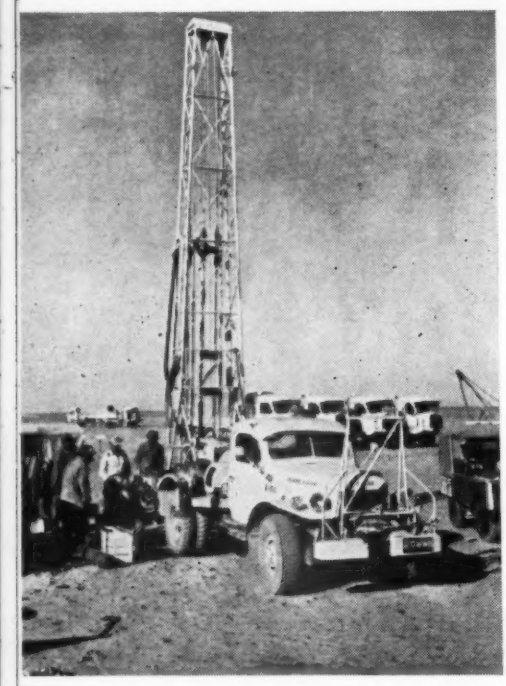


A seismic party about to leave camp on a survey operation. In immediate foreground, a portable drilling rig.

ALGERIAN EXPLORATION

Oil search in Sahara hampered by heat, drought, and distances involved

THE Algerian Sahara, a vast arid region of 772,200 sq miles, has recently attracted attention of petroleum companies, who have been granted exploration permits covering some 231,660 sq miles. The Royal Dutch-Shell Group is taking an active part in this oil search through the Compagnie des Petroles d'Algerie (in which it has a 65 per cent holding), and the Compagnie de Recherches et d'Exploitation de Petrole au Sahara (in which it has a 35 per cent stake). The former subsidiary obtained in early 1953 seven permits for exclusive exploration rights in an area embracing 61,776 sq miles situated south of El Golea and nearly 435 miles south of Algiers.

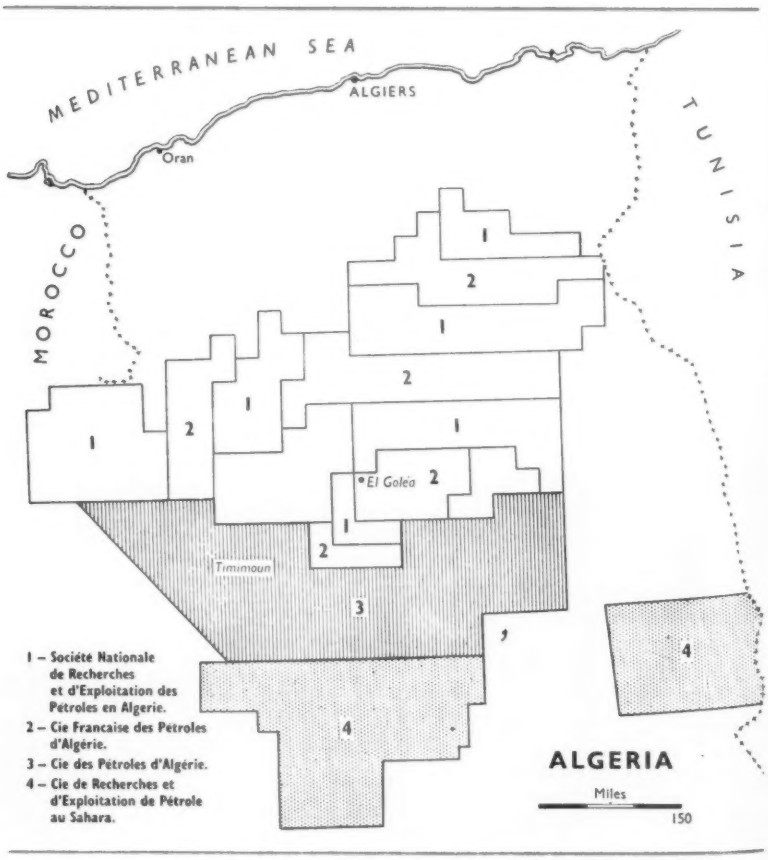
Since its inception this company has done a great deal of reconnaissance work. Progress has inevitably been slow because of extremes of climate, the vast distances involved, and the scarcity of water. For a start, suitable routes had to be plotted for a fleet of vehicles ranging from light jeeps to huge tank trucks. Geophysical parties started operations, the first part of their work being done by gravimetric surveys, and they were followed by seismic groups in early 1954. Two seismic parties are now on the job, and several hundred men—Europeans and Arabs—work together in well organized units. Bit by bit a picture of the underground structure is being completed and when finally interpreted it will enable the various sites for test wells to be decided.

The first heavy drilling rig was put into operation at a site some 12 miles south of Timimoun. It stands at the bottom of a large depression surrounded by rocks and sand dunes, and during the three months prior to its construction convoys had transported over 600 tons of equipment from either Algiers or Oran to the site approximately 621 miles away. There was no water on the site, and so a pipe line about 19 miles long was built to bring the water from Timimoun. Air-conditioned huts, equipped with shower baths and refrigerators, provide reasonably pleasant living conditions for the 30 men employed at this site.

With various parties working over a wide area of the concession the problem of communications and supplies posed considerable difficulties. These have largely been overcome by the use of aircraft and a radio-telephone network, both greatly facilitating communication between the parties and the bases at El Golea and Timimoun.

For work in the Sahara the various parties were provided with modern all-wheel drive vehicles. In the southern sector tracks were laid out with the aid of experts from the Societe Routiere Colas, and some 15 landing grounds near the sites were marked out and equipped for use of chartered aircraft, providing an essential link in the exploration work.

It is too early to forecast whether success will attend these efforts, for in Sahara, as elsewhere, oil exploration is a long-term proposition, and in this particular case the inhospitable nature of the climate and terrain renders the search over such an extensive area doubly difficult. Oil potential, if any, cannot be known for some considerable time yet. * * *



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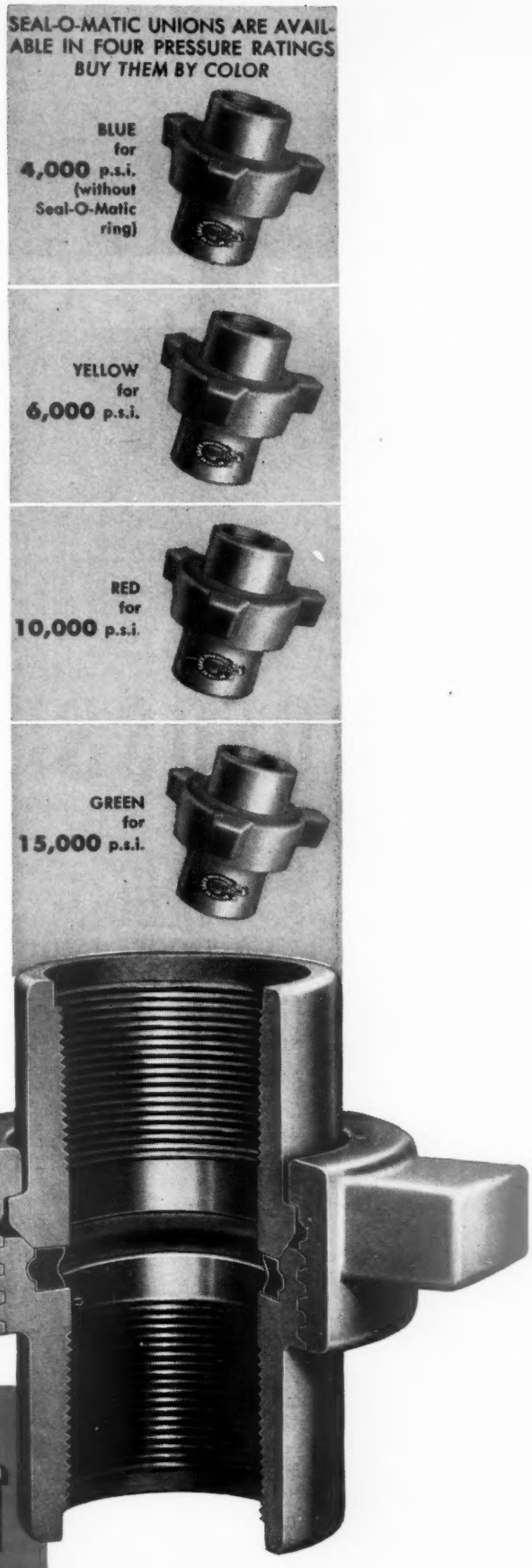
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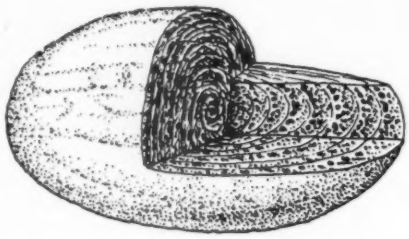
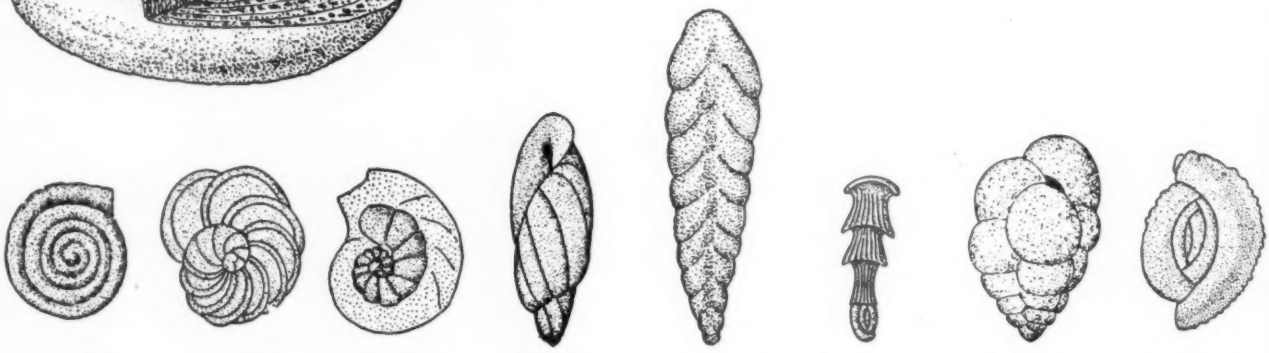


FIG. 1. Left, loftusia persica. One of the "giants" among foraminifera, shown here in actual size. (from (Galloway)

FIG. 2. Representative foraminifera, below, showing some of the variation to be found in this group (from Cushman).



Ammodiscus Planulina Laticarinina Buliminella Spandelina Articulina Eggerella Massilina

MICROFOSSILS

and the Search for Oil

BROOKS F. ELLIS and ANGELINA R. MESSINA

THE search for petroleum goes on with the aid of every useful device man can bring to bear on the problem. These devices or methods fall into two chief categories, those belonging in the field of geophysics and those relating to geology proper. In the former category, such instruments as the gravity meter, the magnetometer, and the exploration seismograph are used. All of these instruments give readings in numbers that can be translated into concepts of "pictures" of subsurface conditions.

The "tools" of the geologist, however, are very different. One of these is diagnostic fossils. Some diagnostic fossils are confined to a very narrow stratigraphic range and at the same time have a rather wide geographic distribution. Consequently, they are good time markers or index fossils. Others are known to live only in specialized environments and so can be used as indicators of environmental conditions of the past. For instance, blue clams indicate shore-line deposits; corals are the inhabitants of warm, shallow seas, and radiolaria indicate deep cold waters.

From the geologists' viewpoint, the most useful group of diagnostic fossils are those commonly designated as microfossils. This is not a taxonomic group as it may include forms from almost any plant or animal phylum. For most geologists, however, "microfossil" means the foraminifera, ostracoda, conodonts, diatoms, algae, spores, and pollen. Even in this more restricted group the range is great since the foraminifera are protozoans, the ostracods are crustaceans, pollen is from angiosperms, and spores principally from pteridophytes and related groups.

Size of Microfossils

Most foraminifera and many ostracodes average about a half mm in diameter. Some foraminifera are 1/200 mm or smaller, whereas a few of the giants measure more than 3 in. in diameter. A huge foraminifera known as Loftusia persica which is all of 2¼ in. in length and externally resembles an over-sized grain of wheat is shown in Fig. 1. Spores are usually somewhat smaller than average sized foraminifera, and pollen grains are among the smallest of all microfossils.

EXCLUSIVE

Structure of Microfossils

Structurally, there is great variation among microfossils. The fossilized portion of foraminifera is a shell-like skeleton known as a "test." The test is made up of chambers arranged in scores of different basic patterns in which there are hundreds of major variants. A few of these basic patterns are shown in Fig. 2.

Structurally, ostracods (Fig. 3 a-c) are basically alike. They are crustaceans with chitinous bivalve shells like those of a clam. The valves or shells are right and left in position in the living animal and often are mirror images of each other. The various kinds are differentiated from one another by relatively small variations in the basic structures and in ornamentation.

Diatoms (Fig. 3 d-e) are small plants with siliceous tests of great diversity and often striking beauty. Variations in shape, difference in proportion, and ornamentation, are all used to differ-

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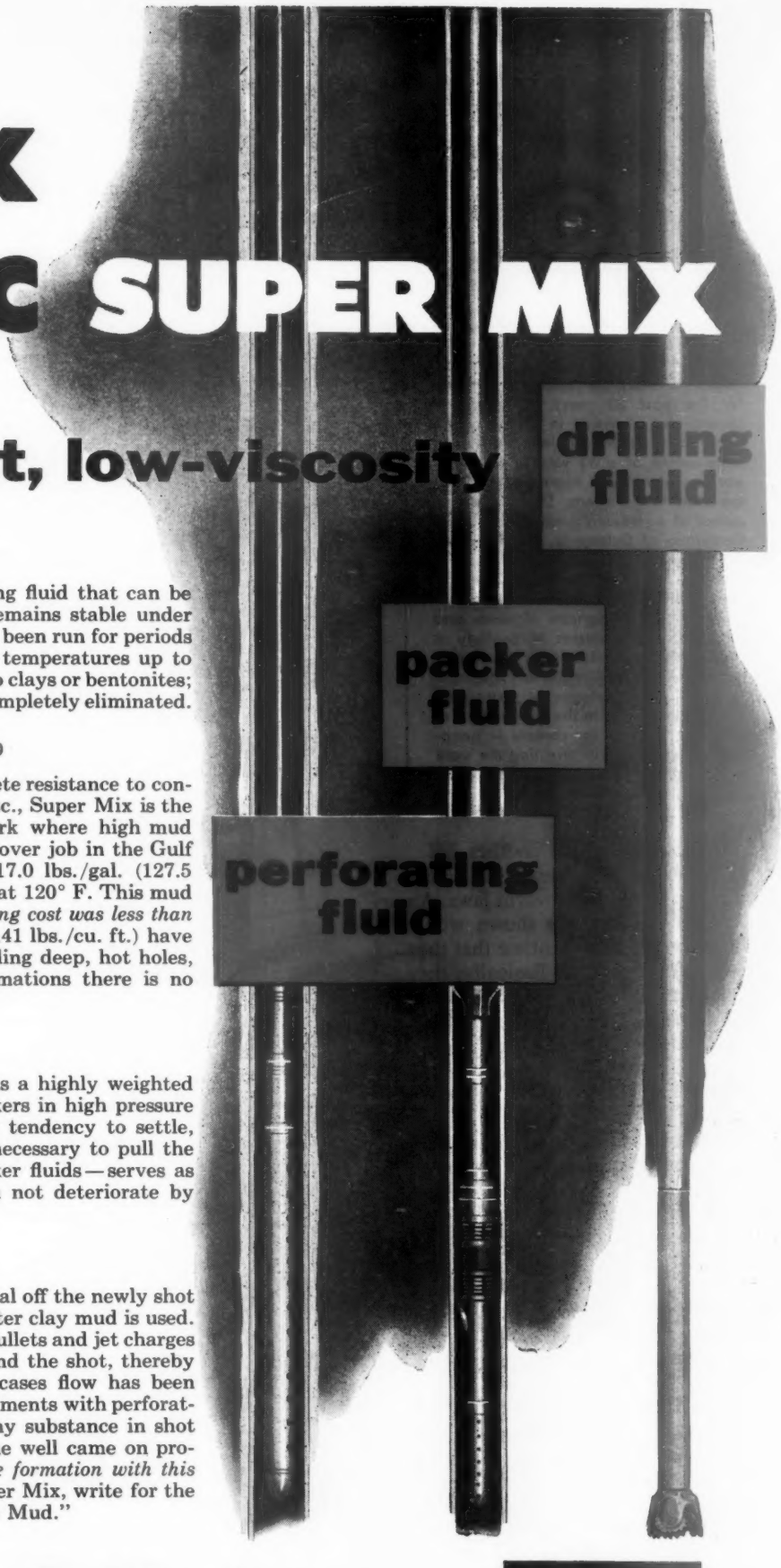

Here is a new, low-viscosity oil base drilling fluid that can be weighted to extremely high weights, yet remains stable under high temperatures and pressures. Tests have been run for periods of four weeks under high pressures and at temperatures up to 400° F. with no adverse effects. It contains no clays or bentonites; problems of high temperature gelation are completely eliminated.

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Super Mix is also being used extensively as a highly weighted fluid in the annulus above production packers in high pressure wells. In no case has the fluid shown any tendency to settle, disintegrate or solidify. When it becomes necessary to pull the packer, the Super Mix—unlike other packer fluids—serves as an ideal drilling or workover fluid. It can not deteriorate by standing idle for long periods of time.

PERFORATING FLUID

As a perforating fluid, Super Mix will not seal off the newly shot holes, as is the case when a fresh or salt water clay mud is used. The excessive heat and force generated by bullets and jet charges actually bakes a hard, solid clay plug behind the shot, thereby minimizing the perforating job. In some cases flow has been restricted as much as 77 %.* In recent experiments with perforating guns, Super Mix produced a soft mushy substance in shot holes which dissolved in crude oil when the well came on production. *No possible chance of plugging the formation with this drilling mud.* For more information on Super Mix, write for the paper—"Recent Developments in Oil Base Mud."

*Effectiveness of Gun Perforating, Journ. Pet. Technology, January, 1954.

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The Authors

Angelina R. Messina is Associate Curator of Micropaleontology at the American Museum and has been engaged in work on micropaleontology for the past 20 years. As Associate Curator she is second in charge of the Department of Micropaleontology and is co-author of a 52 volume reference work on microfossils known as the Catalogue of Foraminifera. She is also co-author of a similar 25 volume work, the Catalogue of Ostracoda, which is now in the process of publication.

Brooks F. Ellis is Chairman and Curator of the Department of Micropaleontology at the American Museum and chairman and professor of geology at New York University. He is the senior author of the Catalogue of Foraminifera and the Catalogue of Ostracoda. Ellis' chief work is in the preparation of graduate students for careers in petroleum geology and in directing the work of the Department of Micropaleontology.

entiate forms from one another.

Most authorities think that conodonts (Fig. 3 f) are tiny worm jaws. An inspection of the forms shown would certainly seem to substantiate that they are jaws of some sort. Basically, they are very much alike, but here again what would appear as minute differences to the layman are broad signposts to the specialist.

Pollen (Fig. 3 g-i) is a well-known substance, but few persons realize that it is capable of fossilization and use in working out stratigraphic problems. But pollen grains have distinctive forms that can be recognized by the specialist. Moreover, because of their small size and light weight, they are often carried by the wind out over marginal areas of the oceans and seas and deposited there in marine sediments. Of course, they occur abundantly in continental beds.

Spores (Fig. 3 j-k) are unfertilized cells capable of growing into new plants. Spores and cases in which they are housed also have distinctive forms and very frequently are fossilized. Consequently, they too are good index fossils, where restricted to definite stratigraphic units, and they serve also as indicators of past geologic environments.

Collection and Preparation

Because of their minute size, microfossils cannot be collected in the same manner as larger forms. A portion of rock which is suspected of containing them, must be examined under a microscope or magnifier before any definite statement concerning their presence can be made. There are exceptions, however, such as the so-called larger foraminifera that are often several centimeters in size.

Samples that may contain microfossils are either surface samples or well samples. The latter category can be divided into ditch samples, which come from the rotary mud that has returned to the surface, and core samples which are taken from cores cut from the rocks through which the drill is passing. Bailer samples are similar to ditch samples but are brought up from the bottom of a cable tool well in a bailer used in cable tool drilling.

Ditch and bailer samples are fragmental while good surface samples are usually relatively large solid chunks. Unconsolidated or minutely fragmented material can be sieved and washed directly while solid samples must first be crushed and then washed and sieved. The crushing is usually started in a jaw crusher and completed in a rolling mill in which the fragments are rolled in water in a glass jar with a steel rod mounted on thin rubber rings for a crusher. This process reduces the sample to a thin mud containing the freed fossils. Several other processes, including simple boiling in water, can often be used quite effectively to obtain the same results.

The mud is removed by the simple process of placing the sample in a fine mesh sieve and directing a jet of water

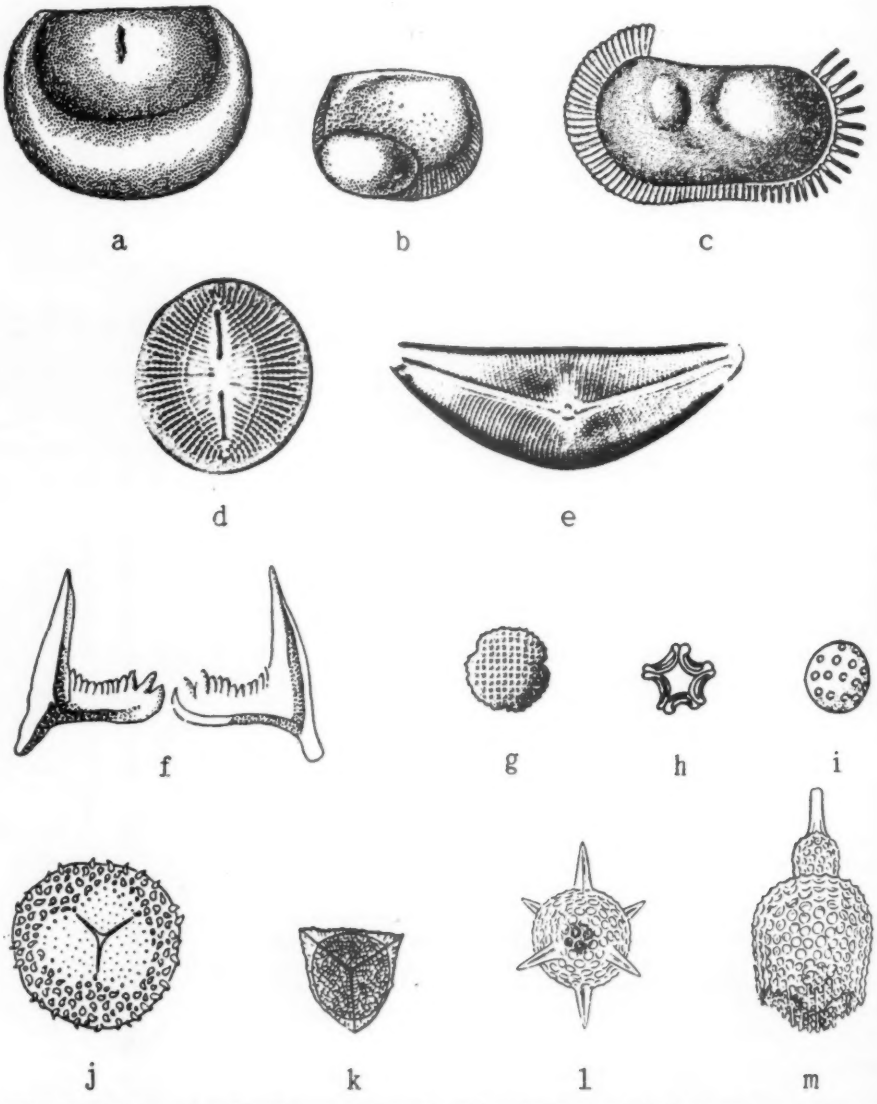

FIG. 3. Various microfossils: a-c, ostracodes (after Bassler and Kellett): a, *Coelochilina;* b, *Apatobolbina*; c, *Beyrichiopsis*; d-e, diatoms (from Shimer and Shrock; d, *Cymbella mexicana,* length 96 microns; e, *Raphidodiscus marylandicus,* diameter 35 microns; f, *Conodont* (after Ulrich and Bassler), *Prioniodus;* g-i, pollen (from Schenck); j-k, spores (from Schenck): j, 560 microns; k, 1400 microns; l-m, radiolaria (from Shimer and Shrock): *Hexalonche;* m, *Anthocyrtium.*

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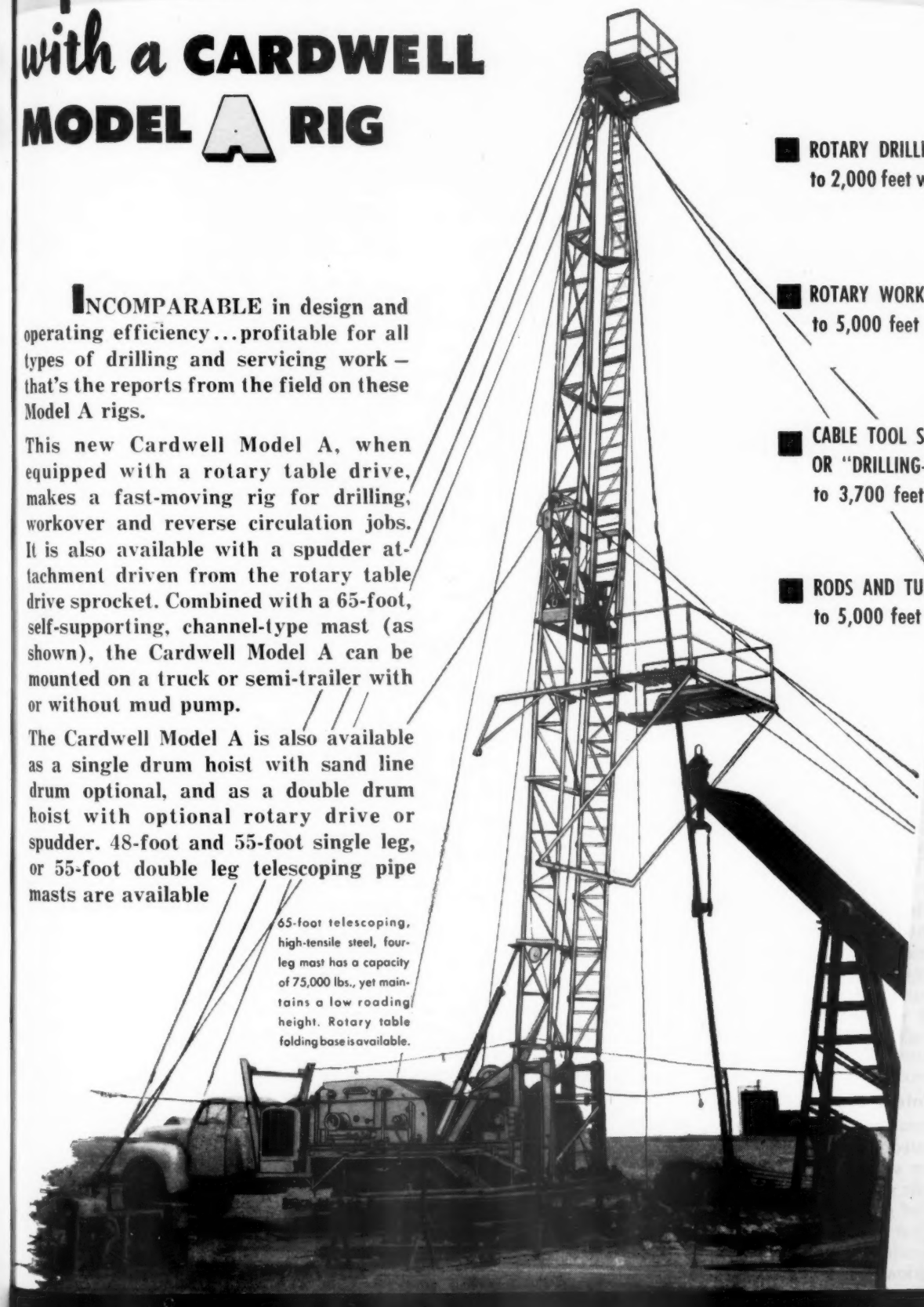

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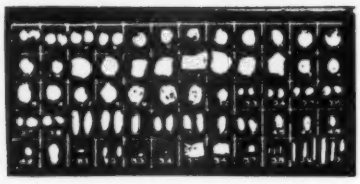


FIG. 4. Faunal slide with foraminiferal specimens mounted on it.

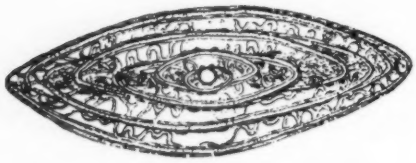


FIG. 5. Thin section of fusuline showing internal structure.

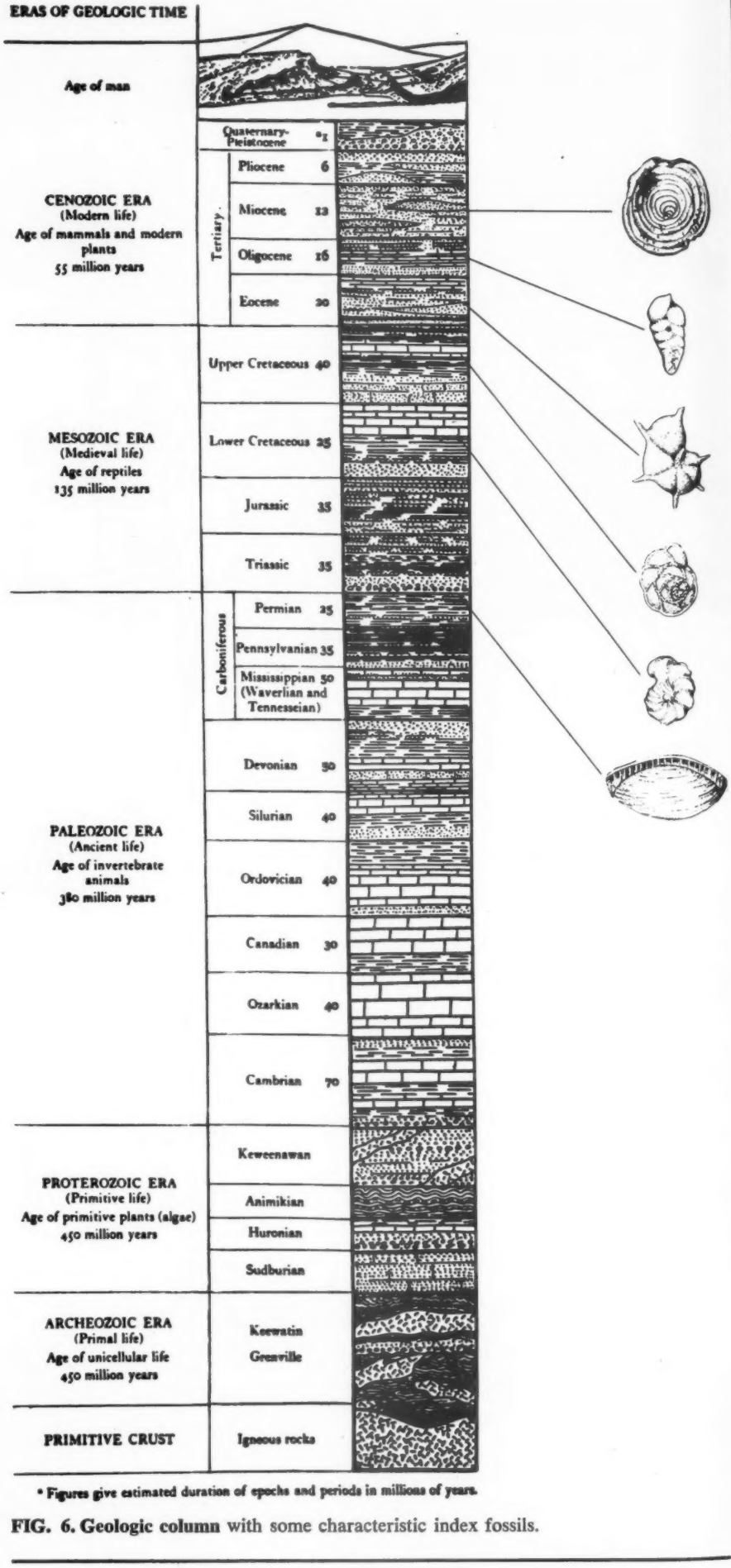
against it. Sieves can also be used to make a rough separation where there is a great size range in the fossils present. Washed samples are then dried and the fossils removed either by picking or by gravity separation involving the use of liquids of different densities. Picking is done by using the moistened tip of a very fine sable-hair brush to which these minute fossils will adhere long enough to permit their transfer to a paper slide (Fig. 4).

An examination of the whole faunal assemblage permits the micropaleontologist to select index forms, and those that tell the story of ancient environmental conditions. This study is made with the aid of a binocular microscope.

The large foraminifera include forms that, externally, are often very similar. Consequently, it is necessary to make thin sections in order to study the internal anatomy that differentiates them from one another. This is done by first, grinding the fossil to a predetermined plane, then cementing the ground side to a glass slide with optical cement. The other side of the fossil is then ground away until only an extremely thin slice is left cemented to the slide. Although the thickness will vary somewhat, it will usually be in the neighborhood of 0.05 or 0.06 of a millimeter, or about twice the thickness of a standard petrographic section. Fig. 5 shows such a thin section of a fusuline.

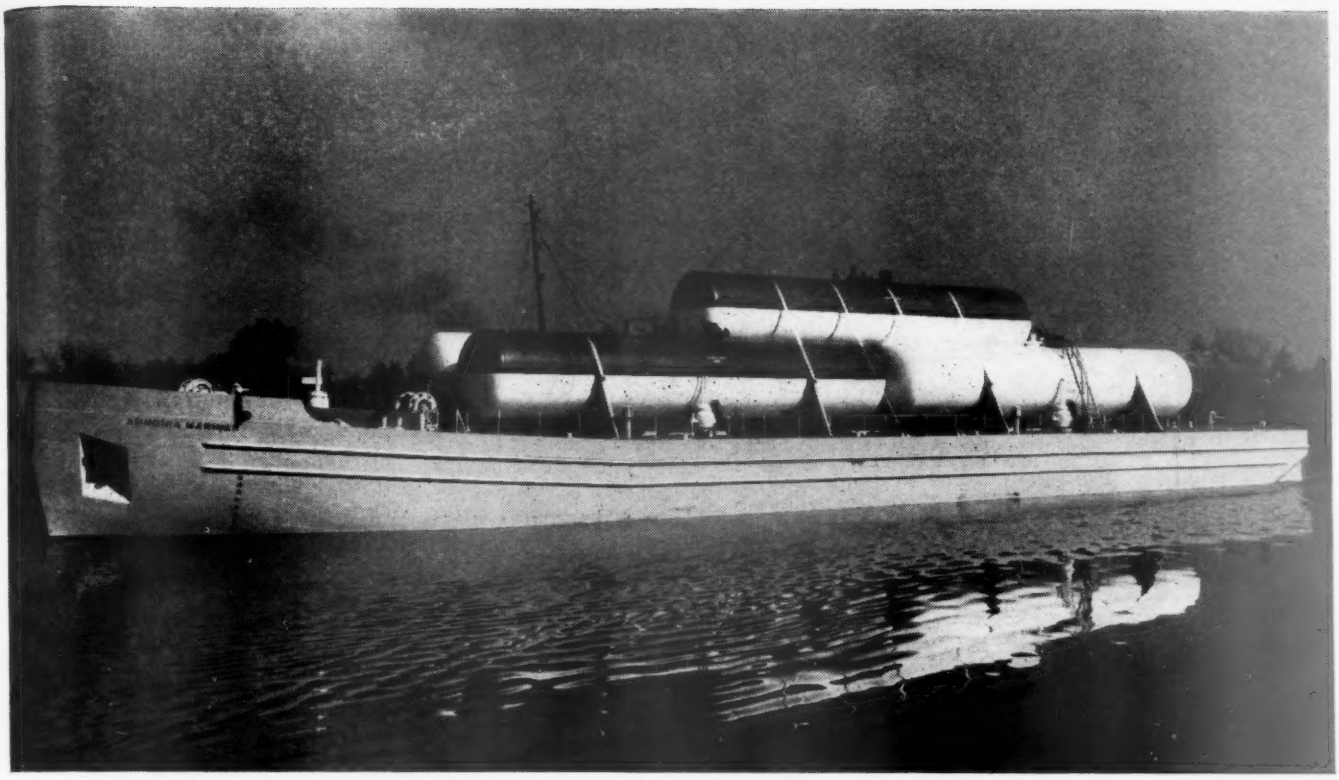
Study and Interpretation

Once the micropaleontologist has his specimens mounted on slides he is ready to begin their study and interpretation. The specific problems he has to solve by the use of microfossils are many and varied, but they fall generally into two categories. The first involves the identification and dating of rock layers by means of the contained fossils. This process is known as organic correlation. The second deals



* Figures give estimated duration of epochs and periods in millions of years.

FIG. 6. Geologic column with some characteristic index fossils.



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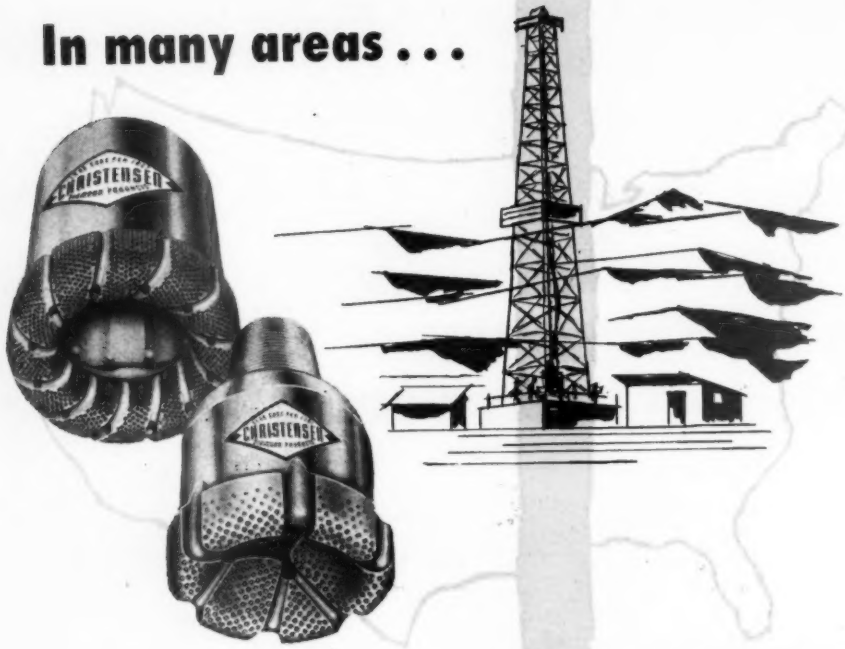

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WILDCAT FIELD, CHEYENNE COUNTY, NEBR.							
Dakota and shale 6⅛"x3½"	700 ft.	4 ft. hr.	$1072.10	**$1.53**	8,000-14,000	60-70	200 gpm
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with the interpretation of ancient environments or the study of paleoecology.

Rock layers can be dated by means of the contained fossils because life has undergone a progressive change since its origin. This change is reflected in the fossils imbedded in the sediments. Old forms disappear or evolve into new ones. Some range through great thicknesses of strata and thus represent long time intervals, whereas others are restricted to a single formation or even a portion of a formation. These are known as "index" fossils.

Correlation

Correlation of beds is accomplished in one of three ways. Assemblages of microfossils in rock layers from one locality are matched with assemblages found in rock layers in another. Consequently, it is possible to establish the fact that one is dealing with the same stratum in different localities without establishing its geologic age, identity, or place in the standard geological column. The process is similar to correlation by electric logs or by lithology.

Correlation can best be done, however, by establishing the geologic age of rock layers and thus tying them in to the standard geologic column. This is done by using "index" fossils, which have been established through experience as markers for the different parts of the geologic column. For instance, the fusuline foraminifera are markers for the Pennsylvanian and Permian periods. Globotruncanas are characteristic of the Upper Cretaceous while nummulites are indicative of the Eocene and Oligocene. Typical index forms and the part of the column they indicate are shown in Fig. 6. Fig. 7 shows how microfossils may be used to locate buried structure.

A more detailed correlation or zonation can be made by using index species rather than major taxonomic groups. In this process, the micropaleontologist may pick "tops," or extinction points, which can be used to correlate minor stratigraphic units. On the other hand, identification may be made through "floods," or the appearance of a given species in great numbers, as in the case of the marginulina or heterostegina zones, so familiar to Gulf Coast workers.

Finally, the association of various species may be distinctive for certain age zones and, once established for an area, can be used very effectively (Fig. 8). None of these methods can be relied upon, however, if only a few specimens are observed and their occurrence noted in a few wells. Large numbers of specimens from numerous wells must be observed and the zona-

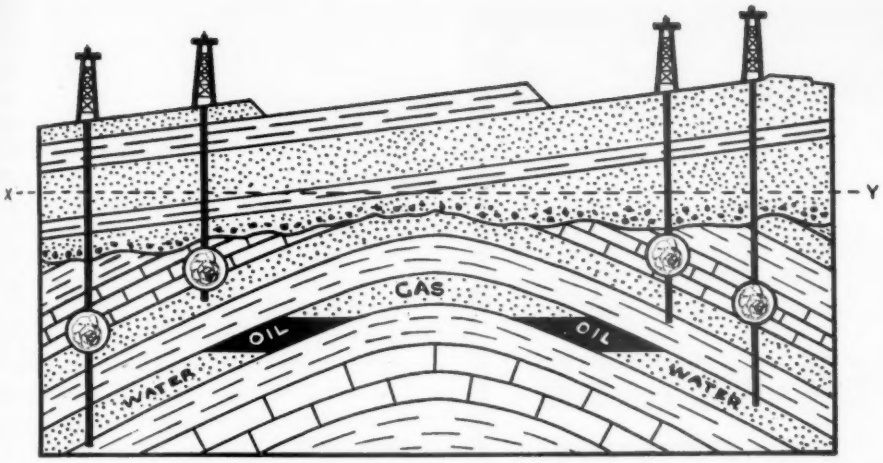

FIG. 7. Diagrammatic illustration of how index fossils can locate buried domes. The same index foraminifera was found at the various depths shown below sea level (X-Y). When plotted on a cross section, the structure, which was not visible from surface, became apparent.

tion, established through their study, carefully and continuously checked, before a reliable result can be attained.

In addition to correlation by matching assemblages and by determining the geologic age of the beds in question, formations may be correlated by matching environmental conditions of deposition. The Nubian sandstone, for instance, occurs over large areas in the Near East, and is believed to range in age from the Paleozoic to the Cretaceous. Lithologically this sandstone is remarkably uniform in character and normally devoid of fossils. Consequently, it is extremely difficult to make age determinations, or to correlate in other ways, its occurrence in different areas. Certain portions of the Nubian sandstone, however, were deposited under conditions that caused the inclusion of fragments of leaves and bits of woody fiber. This condition seems to have been confined to certain layers, so that wherever they are encountered, they may be recognized.

Thus, such beds are said to be correlated by environmental conditions of deposition, rather than by age determination or by matching assemblages. Similiarly, the presence of fresh water diatoms has often been used to distinguish a continental bed from a marine counterpart with which it might well have been confused.

Ecological analysis can also help the micropaleontologist to avoid serious misinterpretations of fossil faunas. One expects a progressive change in faunas as younger and younger assemblages are considered. Local ecological conditions may often impose temporary characters on succeeding generations which characters are completely out of step with evolutionary development. This may confuse the unwary observer and cause him to assign the apparently different fauna to a portion of the column to which it does not belong. Training in ecology can help him to avoid these tricks that Nature sometimes attempts to play on him.

Ancient Environments

Perhaps one of the most interesting and significant results of the study of microfossil ecology is that it enables micropaleontologists to reconstruct the environmental conditions of the past.

Certain micro-organisms are typical of warm waters, others of cold. Some live at considerable depths below the surface and others very close to it. Some forms are exclusively bottom dwellers, other are floaters or planktonic forms. Certain physical characters of these organisms usually reflect the environment in which they are found. Consequently, these habits observed in living representatives of the group can also be applied to fossil forms having similar physical characteristics. For instance, arenaceous forms are typical of areas of turbulence. Forms having light tests and inflated chambers are typically floaters, whereas those living in areas of strong wave or current action normally develop heavy shells.

From the mass of information accumulated over a long period of time by men working with these organisms, it is quite possible for micropaleontologists to reconstruct, rather accurately, conditions that existed in the past. An

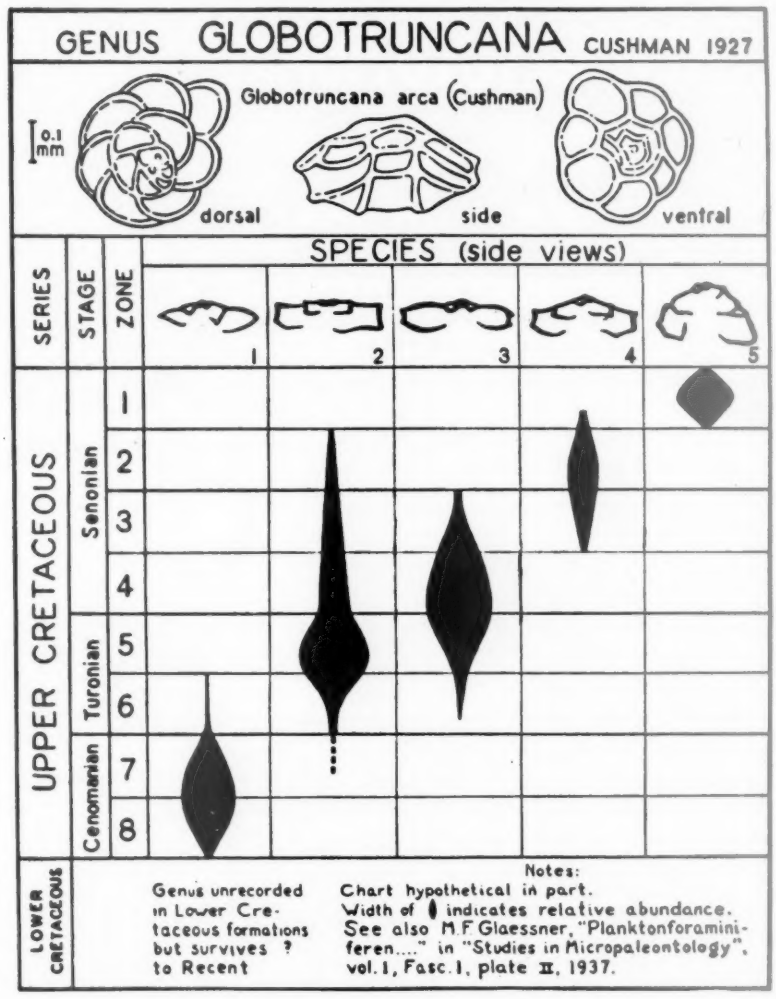

FIG. 8. Chart showing stratigraphic distribution of Globotruncana. Zone 1 can be delimited by species 5, where it occurs as a "flood". Zone 3 is identified by combinations of species 2, 3, and 4; and zone 6 by species 1, 2, and 3 (from Schenck).

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example will best illustrate how this is done. In the Black Sea, there are presently large areas in which black organic muds are collecting. Bottom dwellers or benthonic foraminifera are never found in these black muds. Floating forms are found in them, however, since they drift into the toxic waters above the organic muds, are killed by the H_2S gas, and settle to the bottom. Consequently, similar occurrences of fossil pelagic foraminifera, without accompanying bottom dwellers, would indicate similar conditions of sedimentation in the past. As such conditions have often been responsible for petroleum source beds, the importance of this type of observation is apparent.

The genera *Alveolinella and Marginopora* are usually found in coralline rocks. Fossil occurrences of these forms have sometimes led to the detection of buried reefs before their presence was suspected from the lithology of the deposit. Such a fact, of course, is of great importance in the search for reservoir beds.

Trends

In view of these examples it is at once apparent that the study of ecology is a most important phase of micropaleontology. Indeed, it may well be said to represent the modern trend in this field. Consequently more and better biological training has become imperative for those expecting to do this sort of work as a profession. The use of statistical methods of study is also on the increase while new and better methods of preparation are constantly being sought. As a result, the service that micropaleontologists can render to the petroleum geologist is constantly widening and increasing in its importance. When one considers that the application of microfossils to the solution of practical problems in stratigraphy does not antedate World War I, the progress that has been made thus far is indeed astonishing. Micropaleontology may well be classified as one of the finest "ivory towers" that has ever gone to work. * * *

Oil Hunt Expensive

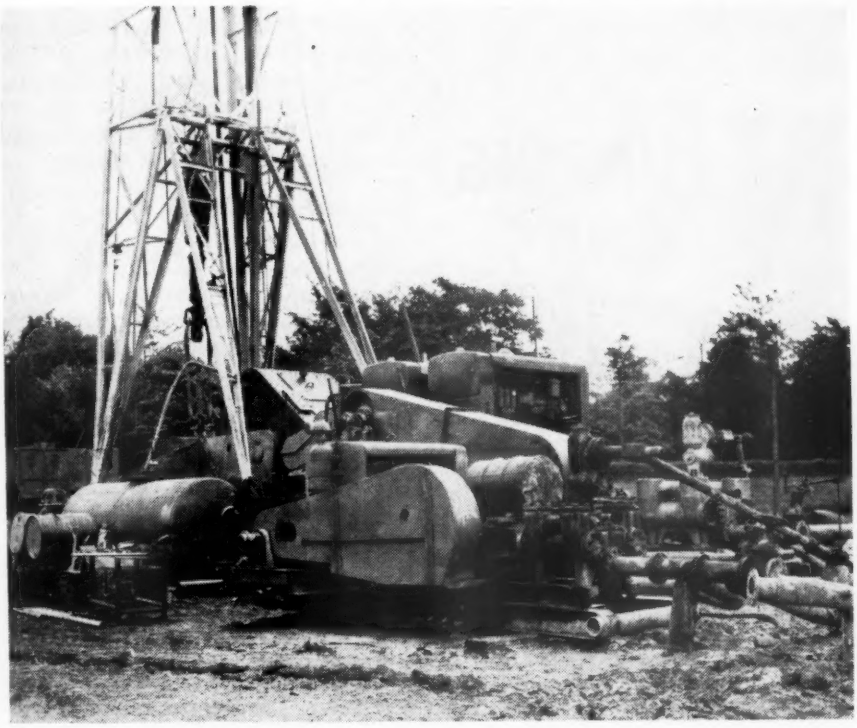
Texas petroleum industry's drilling bill runs into the millions of dollars daily, according to recent estimates by Texas-Mid Continent Oil and Gas Association. Specifically, the industry is spending some $2,300,000 a day seaching for new fields and developing those already in operation.

The petroleum industry touches many segments of Texas economy. There are 41,000 employed directly in drilling operations of numerous kinds.

Annual United States gold and silver ore yields run about $112,000,000. This would pay Texas' petroleum bill only a month and a half.

Britain Searches for Natural Gas

Drilling rig with power units at the Crowborough Warren, Sussex, site of the Gas Council's search for natural gas.



A 5-year exploration program is begun in attempt to supplement country's fuel source

V. S. Swaminathan

TWO main reasons—mounting cost of coal and increasing scarcity of this solid fuel suitable for carbonization—prompted the decision of the Gas Council to search for supplies of natural gas in Britain. During the financial year ended March 31, 1954, coal purchased by the domestic manufactured gas industry was $84,000,000 a year more than it would have paid at prices ruling 5 years previously. Moreover, the Anglo-American productivity team, reporting on the gas industry, wrote that "although there are no appreciable known reserves of natural gas in Great Britain a discovery of any magnitude would be of immense value to our national economy, and it is suggested that prospecting, where there is any possible hope of success should continue to receive vigorous support." The industry is determined not to overlook any opportunity to provide gas supply from sources that do not diminish the steadily dwindling coal reserves.

EXCLUSIVE

As a result of a report from Dr. M. G. Lees, then chief geologist of the Anglo-Iranian Oil Company,[1] the Gas Council felt sufficiently encouraged to decide to conduct a large-scale exploration for natural gas. It concluded an agreement with the AIOC whereby the latter would undertake the exploration program. The AIOC's subsidiary, D'Arcy Exploration Company, Ltd., has had experience over a long period and in many parts of the world, of the geological work and drilling entailed. The cost of exploration is estimated at $2,800,000, spread over the planned 5 years' search.

Natural seepages of gas at surface or in underground workings, of which there are many in Great Britain, are proof that some gas exists in the area, but it is rarely possible to deduce from them with certainty the positions of the accumulations from which they are escaping. They throw little, if any light, on the volume of gas remaining in the reservoir. Most proved gas fields have been found in the crests of anticlines where, with or without an oil body between, gas in the minute interstices of the reservoir rock rests on water that normally would occupy such pores.

In Britain about one-fifth of the land area is underlain by sedimentary rock that fulfill, in greater or lesser degree, the basic requirements for gas formation. The exploration program will investigate and test three principal types of prospect:

a. Those in Permian limestones where the beds lie beneath evaporate deposits (salt, anhydrite, etc.);

b. Those in sediments of Carboniferous age, and

c. Mesozic prospects, mainly of Jurassic age, in southeastern England.

Permian Prospects

The Permian limestone prospects are restricted to an area of rather more than 4000 sq miles lying along the east coast of Lincolnshire and Yorkshire between the River Tees and the Wash. Similar positional conditions in Permian times extended eastward across Holland and northwestern Germany, where commercially valuable gas fields have been found. At Eskdale near Whitby in Yorkshire such a gas accumulation was found by the D'Arcy Exploration Company, and its extent is now being investigated jointly with Imperial Chemical Industries, Ltd.

In planning the current exploration program the highest priority has been accorded to this type of prospect because it is considered that it offers the best chance of finding gas fields of substantial size. As surface data and other information now available is inadequate to indicate the whereabouts of favorable structures in the Permian

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limestones, a geophysical survey is being made of the entire prospective area employing two seismic parties.

Sediments of Carboniferous age include prospects where natural gas has been formed in circumstances favorable for generation of crude oil, and others where gas is more closely associated with coal. Evidence in Britain suggests that the former prospects are likely to be more successful than the latter, but much has yet to be learned in this matter. The total area with Carboniferous gas prospects is of the order of 13,000 sq miles, of which about half lies in Nottinghamshire, Lincolnshire, northeastern Yorkshire, and Durham, and extends much under the area of Permian prospects. Some 3000 sq miles in Cheshire and Lancashire, 2000 sq miles in the Bath-Cotswolds area, and about 1000 sq miles in the midland valley of Scotland comprise most of the remainder of this type of territory.

Carboniferous Formations

It is likely that the first test of a Permian prospect will be carried deeper to explore Carboniferous formations. The vast amount of geological information available from surface evidence and that obtained from mines, water wells, and other bore holes is being reexamined and scrutinized. Results of this work probably will lead to further test drilling following more geophysical, structural, and stratigraphic surveys.

Mesozoic gas prospects occur within an area of about 4000 sq miles lying in eastern Dorset, Hampshire, Surrey, Sussex, and Kent.

As early as 1938 drilling was begun at Cousland in Midlothian, Scotland. Then D'Arcy Exploration Company, engaged in prospecting for oil, found that there were reserves of natural gas in the area. At that time it did not seem advisable to take advantage of the gas discovery and the well was sealed off. Knowing that reserves already had been proved in the area, however, it was agreed that an early part of the Gas Council's search should be carried out there. Accordingly in early 1954 deep drilling was carried out on a site close to that of the original well. Results obtained were not encouraging, but it was deemed worthwhile to undertake further tests so that the true extent of the supply in the Cousland area could be ascertained. Geologists are now assessing the results obtained from the second well, and it may yet be that, following their recommendations, a third well may be drilled in this area.

Survey work is in progress in Yorkshire and Lincolnshire, and additional drilling sites are to be selected in these counties the basis of reports of geologists and seismic parties. In November,

1953, exploration work for natural gas was begun some 10 miles from Beverley at Aldbrough in southeastern Yorkshire. The line prospected extends from Aldbrough on the seacoast through Beverley to Market Weighton. Late in 1953 a second seismic party began work in Lincolnshire; the line worked out by it was from Stixwould passing south of Louth to the southeast coast.

Exploration in Sussex

It has long been known that natural gas exists in Sussex, and the railway station at Heathfield was lit by such gas for many years. The initial program in this area consisted in drilling a series of shallow core holes in a rough line from a point near Wych Cross to Ticehurst to gain additional knowledge of the underground contours of this area, which, it is thought, may contain natural gas. Following this the site at Crowborough was chosen for the drilling of a deep well.

Party consists of 10 technicians, with drivers and workmen, totaling about 20. They are equipped with light drilling outfits for boring shot holes. Each hole is about 100 ft deep and 5-in. in diameter.

Britain is a closely settled and densely populated country so great care is taken in the preparation of drilling sites to avoid permanent damage in any prospecting area. The fertile top soil is removed and piled to one side so that eventually it can be replaced. Any crops damaged, or those that must miss their normal rotation, are fully covered by compensation, as are hedges, fences, or gates that may have to be removed to allow access. In seismic work, where the equipment is much lighter and remains at a given place for only a day or two, removal of the topsoil is not necessary.

Exploration, especially in a country where production of natural gas has not been proved on more than a minor scale, is essentially a hazardous undertaking. Considering the variety and nature of the circumstances it would be altogether unusual if the 17,000 sq miles of prospective territory in Britain failed to yield sufficient gas to pay for the cost of its exploration and of the facilities required to put it on the market. Nevertheless, it would be unduly optimistic to expect production on the scale of the great gas producing areas of Canada or the United States, or even sufficient output to alter radically the present pattern of energy consumption in Britain. Even though initial efforts fail to show positive results, both the Gas Council and D'Arcy Exploration Company hope that in the course of the five years' search a measure of success will come in one area of another. * *

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T. G. HUGHES

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The Author

T. G. Hughes is president of Oronite Chemical Company. After a period in Standard of California's natural gasoline department, Hughes began in the petrochemical business by making emulsified asphalts with American Bitumuls Company. Oronite was born in 1943 and Hughes was made a director and executive committee member. Hughes, who was made president in 1950, has helped the company grow from a half-dozen products in 1943 to, among other things, the biggest supplier of synthetic detergent intermediates from petroleum in the world.

IN recent months one has been hearing and reading a great deal about the swift and widespread expansion of one of this country's new industries—the petrochemical industry. The name itself, coined by some enterprising ad man, has a fine ring of promise. It connotes the mating of two great industries—petroleum and chemical—to give birth to a wholly new realm of enterprise.

From its beginning in the 1920's, the petrochemical industry has grown to a business with an investment of some 3 billion dollars. One hundred seventy-six companies are operating, or have planned, 322 plants in the United States and Canada. Of these 62 are petroleum companies, 102 are chemical companies, and 12 are joint ventures.[1] Investment houses, a good barometer, consider petrochemicals one of the best growth industries with good future returns promised in relation to the risk.

With all of this in mind, you might conclude that petrochemicals bid fair to alter the traditional markets for crude oil and gas. You might even say it's beginning to look as though the petrochemicals tail, before too long, will be wagging the petroleum dog. If that's really the case, it should have a significant effect on the oil and gas producing industries. But let's take a closer, more critical look at our petrochemical tail and see just low strong it is, how influential it figures to become.

First of all, what makes petrochemicals so attractive to investors and, of course, in their final forms, to consumers? Taking a few of the more outstanding examples, consider first the synthetic detergents. This industry, you will recall, had its big beginning immediately following World War II when the base material now used in practically all of the synthetic detergents was developed from petroleum. The excellent cleaning ability of the products, and particularly their resisttance to hard water, no soap scum, gave them rapid acceptance by the housewives. Fig. 1 shows the history of their rise in popularity.

The first products, you may remember, were used primarily for washing dishes. In 1948-1949 the soap companies developed special formulations that extended their use to the washing-machine field, so that now nearly 60 per cent of the soap company sales are based on petroleum-derived synthetic detergents. Of course, the rate of increase is slowing down appreciably as the line approaches the total soap and detergent sales.

Petrochemicals are assuming major importance in the plastic field. From Fig. 2 it will be seen that plastics have also been a rapid-growth industry. It is reasonable to expect the growth will continue in those applications where their special properties justify their higher cost. Today you can buy everything from polyethylene squeeze bottles to sports cars molded from petrochemical plastics. Although their growth has been spectacular, their consumption in pounds is still less than 1 per cent that of other structural materials, which leaves considerable room for expansion.

Dacron*, Polyester Fiber, and most of the new synthetic fibers coming into wider use are petroleum derivatives. Their advantages, such as resistance to wrinkling, long wear, and appearance, are making them increasingly popular. By way of illustration, Fig. 3 plots the growth of synthetic fibers against the natural fibers such as cotton and wool.

Rayon is not included in the synthetic-fiber statistics, as it is largely derived from wood pulp. Let me caution you against trying to extrapolate the synthetic-fiber curve and reach the conclusion that cotton will be displaced by petrochemical fibers before 1970! Although the consumption of synthetic fibers is about 200,000,000 lb, it is still only 4 per cent of cotton consumption. As the percentage rises, the rate of growth will undoubtedly slacken.

You find petroleum chemicals in almost every field of use today— Synthetic rubber, gasoline and lubricating-oil additives, paint, insecticides, and medicines, to name a few. The variety of products and the untapped potential capture the imagination. A luncheon speaker in our area is making a hit talking about chemicals that come out of petroleum's "magic barrel."

But stripped of the magic — and illuminated in the cold light reflected by a silver dollar—what effect is all this going to have on your business, the business of producing oil and gas? To answer that, consider the basic characteristics that many petrochemicals have in common.

First, they derive their value and their utility, not from the intrinsic value of the raw material from which

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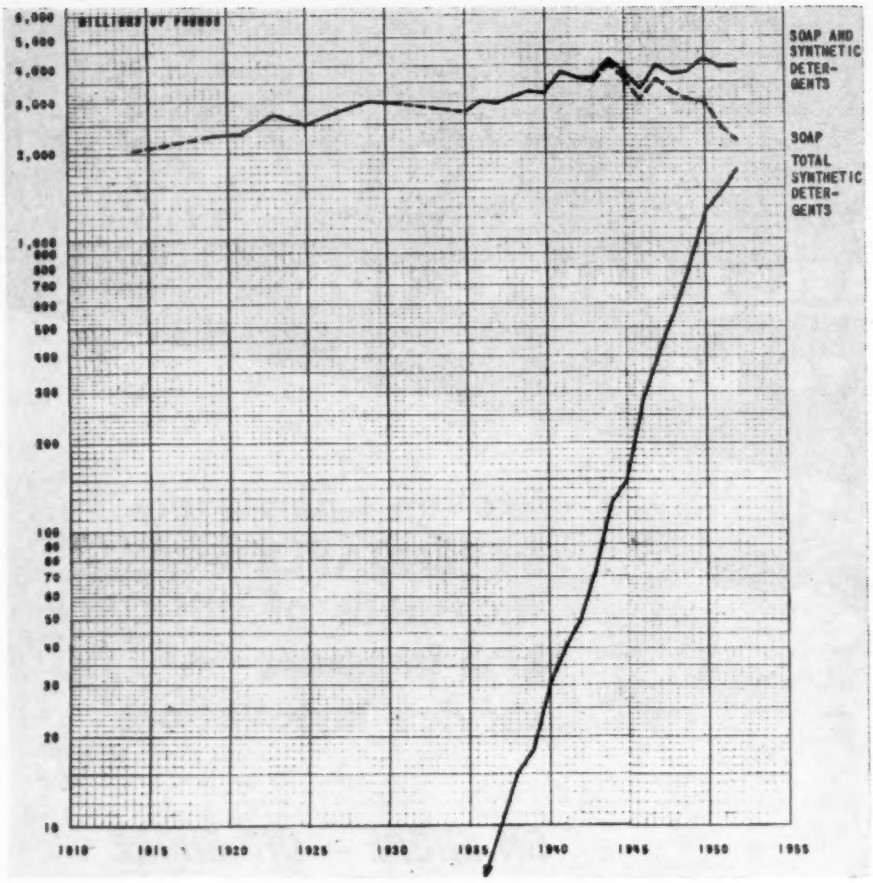
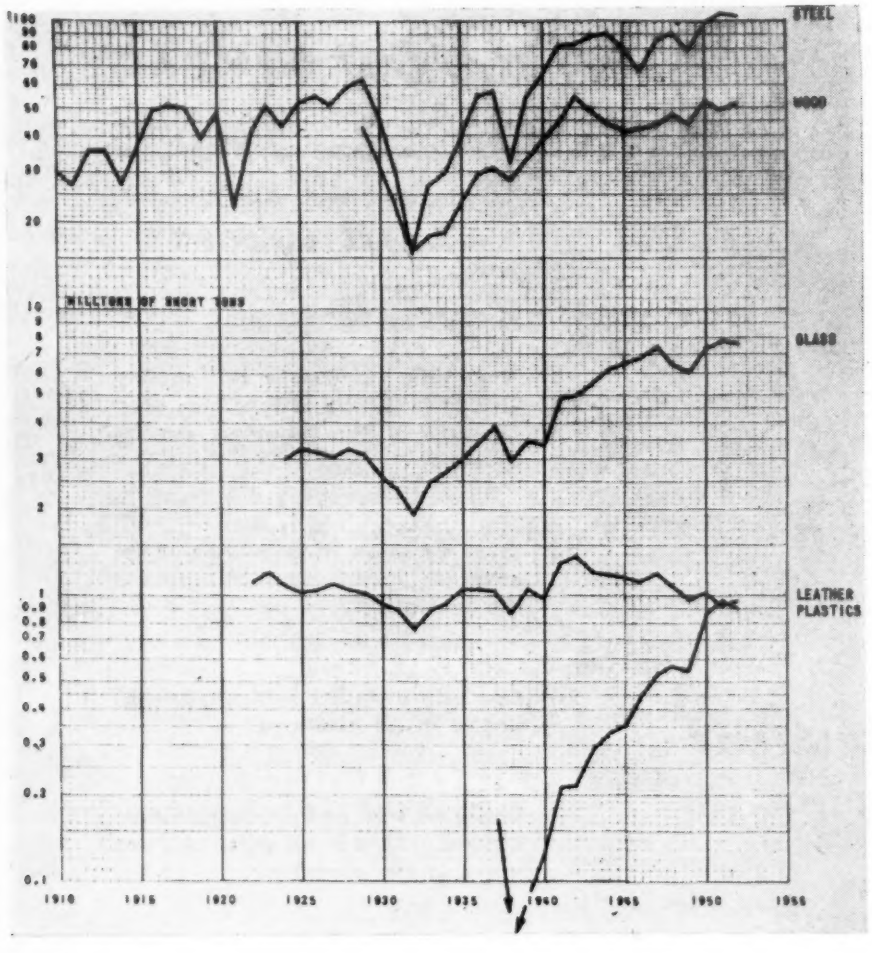


FIG. 1. Production of soap, synthetic detergents, up to 1952.

FIG. 2. Consumption of plastics and of competitive materials up to 1952.



they originate, but from complex and costly manufacturing processes. Second, although we refer to these chemicals as petrochemicals, many can be manufactured just as readily from alternate raw materials, such as wood, coal, and even molasses. A classic example is du Pont Nylon in which the same intermediate chemical is being produced from six different sources, as indicated in Table 1.

TABLE 1. Nylon raw materials.

Raw-material source	Raw material
Natural gas	Butane
Gasoline fraction	Cyclohexane
Coal tar	Benzene
Oat hulls, Corn cobs, Sugar-cane bagasse	Furfural

Now, because the price is favorable, oil and natural gas are pulling ahead of materials in many lines of chemical production—Nylon among them.

This following tabulation lists some other leading products and the percentages manufactured from petroleum and the alternate sources.

Chemical	Per cent now produced from petroleum	alternate raw material
Ammonia	85	Coal
Methyl alcohol (formely called) wood alcohol)	80	Coal and wood
Ethyl alcohol	57	Molasses and other agricultural products
Toluene	60	Coal
Xylene	86	Coal

Each of these products, 30 years ago, was manufactured entirely from materials other than petroleum. So that gives an idea of how far petroleum has come in this competition.

I don't want to convey the impression, however, that oil and gas have won and the contest is over. Advances are also being made in the technology of converting coal to chemicals. Carbide and Carbon, for example, is reported to be operating an 11-million-dollar pilot plant turing 600 tons of coal a day into aromatic chemicals by coal hydrogenation.

The significance of all this to oil and gas producers should be clear; and it is this: The prosperity of the petrochemical industry depends fundamentally upon big-volume, low-cost sources of raw materials.

The price has to continue to be right. If the value of crude oil or natural gas reaches the point where the alternate raw materials can come back strongly into the picture, then the petrochemical industry will begin to tail off and we'll see a booming coal-chemical industry, or a molasses-chemicals industry—or a corn-cob-chemicals industry—whatever happens to be cheapest. In short, I submit that very few oil and gas pro-

ducers are going to wax very prosperous solely on account of the growth in petrochemicals.

Before I am accused of wielding a wet blanket, however, I hasten to add that this does not mean that some producers, those who are properly located and have sufficient long-range reserves, will not be able to profit from doing business with petrochemical industry.

The next questions to consider, then, are: Which petrochemical markets will oil and gas producers be able to serve profitably? How big will those markets be? Here are the answers, as they are seen by the author:

First, with respect to crude oil, the existing market pattern is not going to be altered by the expansion of petrochemicals. As it is known, crude oil is composed of many thousands of different chemical compounds and many more are formed during cracking or other refining operations. Only a small portion of these are desirable for the manufacture of petrochemicals. Thus, a fully integrated petroleum refinery is needed to separate the small percentage of desirable types for chemicals and to consume the large remainder in conventional refinery products.

Although it is true that many refineries, particularly the larger units, are entering into petrochemicals, their chemical production in oil-company units of barrels per day is small compared to their overall petroleum consumption. For example, one of the largest operators in the petrochemical business has a chemical production of less than 15,000 bbl per day, which is about 3 per cent of the crude-oil throughput.

Next let us consider natural gas and LPG. This is the segment of the industry likely to be more directly concerned with the petrochemical industry. In these products, we are dealing primarily with only four molecular species. As is known, methane is in greatest abundance with smaller quantities of ethane, propane, and butane. Relatively simple processes, by chemical-industry standards, are needed to isolate the fractions of natural gas or LPG for manufacture of chemical derivatives. Thus, petrochemical companies can be direct customers. First, let us look at some of the chemicals

TABLE 2. Chemicals from methane.

Chemical	Major end use
Ammonia	Fertilizers
Methyl alcohol	Anti-freeze and raw material for formaldehyde (used in plastics)
Hydrogen cyanide	Plastics and synthetic fibers
Acetylene	Welding, vinyl plastics, and neoprene rubber
Methyl chloride, methylene dichloride, chloroform, and carbon tetrachloride	Solvents and refrigerants
Carbon black	Rubber compounding

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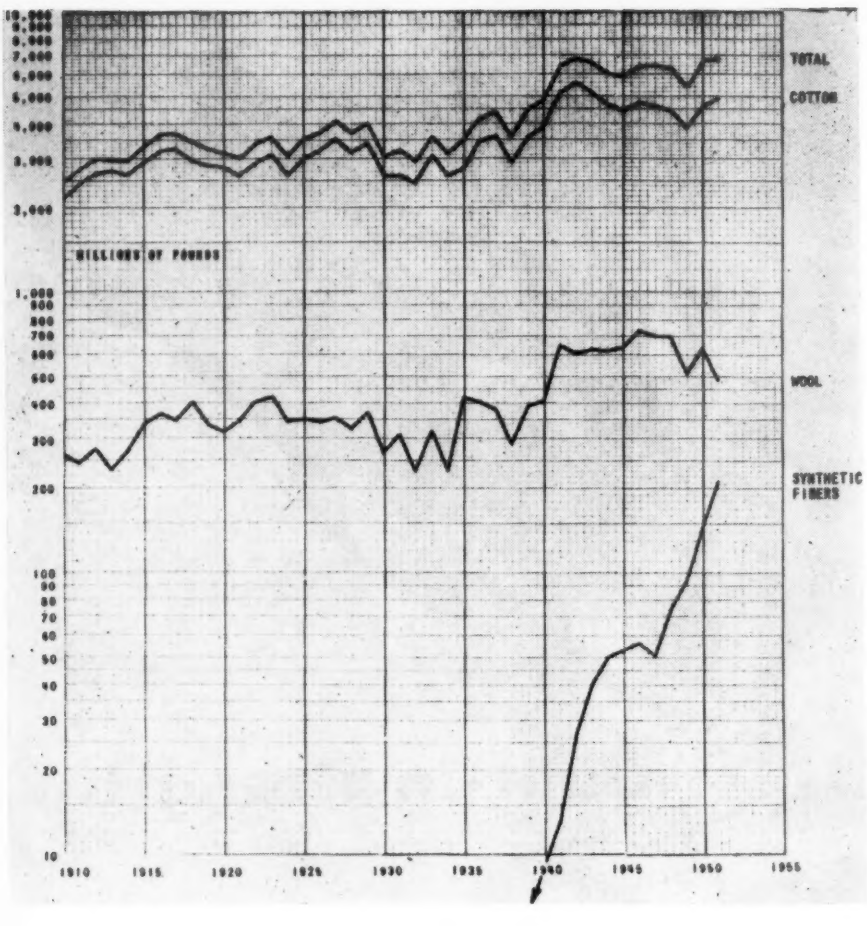

FIG. 3. Consumption of textile fibers in recent years.

now being made from one of these raw materials—methane.

As we go on to ethane, propane, and butane, the number of chemical derivatives becomes much greater and far too numerous to list here. Several dozen major chemical products are involved.

Many of the plants making chemicals from natural gas and LPG are thirsty consumers of raw materials. For example, a single ammonia plant may consume some 8,000,000 cu ft of natural gas daily for a production of 200 tons a day of ammonia. A butadiene plant for synthetic rubber could use around 115,000 gal a day of normal butane for an annual output of 50,000 tons of butadiene.

Now, suppose you are a producer of natural gas and you wish to consider participating in the petrochemical field. What are some of the factors in determining whether a petrochemical plant could be attracted to your location? Fist and foremost, you must have an assured long-range source of supply. Chemical plants are expensive to build. Investments of $10 to $20,000,000 per plant are not uncommon. Quite obviously, no chemical producer is interested in investing money of this mag-

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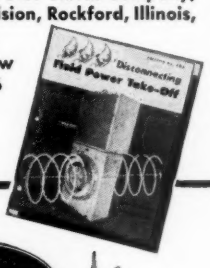

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nitude in a plant that may be shut down by running out of raw materials.

Second is the value of the gas. As mentioned earlier, the chemical industry is highly competitive at all levels and low-cost raw material supplies are essential. Stability of both supply and price have been important factors in the increasing consumption of petroleum as a raw material for chemicals.

The third item is strategic location. As in the petroleum industry, freight costs are important, particularly on low unit-value items. Consideration of each chemical project involves detailed calculations on the relative economics of transporting raw materials vs. transporting finished products. There is no single generalized answer. An interesting recent compromise is the selection of sites along large gas pipe lines.

One case in point is the National Petro-chemicals Corporation's plant at Tuscola, Illinois. It is located on the Panhandle Eastern Pipe line and is owned 40 per cent by Panhandle Eastern and the balance by National Distillers. This, incidentally, is a good example of how diversified the chemical business can be. Even the whiskey manufacturers are getting into it. Another plant is at Greensburg, Kentucky. It is jointly owned by Tennessee Gas Transmission and Mathieson Chemical, and is on the gas company's line.

If you are able to make the first three hurdles of long-range supply, low value, and strategic location, then you come to other local considerations. These woud be common to any refining operation and would include items such as adequate labor supply, availability of reasonably priced utilities, and low land costs. If you can match these requirements, then you are in position to do business with the chemical industry.

The problem then becomes one of finding an organization which has, or thinks it has, sufficient market for a long-scale low-prduction-cost chemical plant. It must also have a fat pocketbook, a desire to gamble, and the know-how to carry the project to successful plant completion and operation. The advantage to you would be acquiring a steady customer for a good many years.

Two additional questions remain to be answered. I have talked in generalities about the growing petrochemical industry, but just how big is this industry likely to become, and what will it mean in terms of its consumption of crude oil and natural gas?

Considering the question of growth first: This year, the manufacture of petrochemicals will amount to about 30 billion pounds with a value of about 3½ billion dollars. For comparison, the total annual field value of crude oil and natural gas produced in the United States is about 7½ billion dollars. You are undoubtedly familiar with the report published by the President's Materials Policy Commission. According to their estimate, by 1975 the manufacturing volume of petrochemicals will be around 54 billion pounds. That is better than 150-per cent expansion.

Now—what about the second question: What will this growth mean in terms of oil and gas consumption? The answer—from your point of view this time—is not very much. To be perfectly frank, the volume of consumption by petrochemical manufacturers, in relation to total national petroleum production, is insignificant. Right now, less than 1 per cent of the crude oil and gas produced in this country is winding up in petrochemicals.

The outlook for the future, as you might suspect, is better but still relatively modest. Using the figures of the President's Commission again, their guess is that by 1975 the chemical people will be consuming about two per cent of total oil and gas production.

Table 3 shows the whole picture, projected at five-year intervals.

TABLE 3. Oil and gas consumption by petrochemical industry.

(Estimates by President's materials policy commission)

	Natural gas MMCf per day	Oil bbl per day	Per cent of total natural gas and oil
1950	180	36,500	.68
1955	390	80,000	1.1
1960	530	116,000	1.4
1965	650	152,000	1.6
1970	760	186,000	1.8
1975	870	225,000	2.0

As you can see, it gives promise of substantial growth—but I suspect that these figures will not excite many of your producers.

To sum up, let me repeat what I said earlier: The growth of the petrochemical industry will not come anywhere near revolutionizing the market outlook for oil and gas production. Some individual producers—those who are able to meet the special requirements of petrochemical manufactuers—no doubt will find it advantageous to be the suppliers of raw materials for this growing, new industry. But the *tail* will *not* wag the dog.

That's the story. If it does not come exactly as a surprise to you, I hope that it at least has served to confirm your own convictions, and to help put what you have read and heard about the petrochemicals into its proper perspective.

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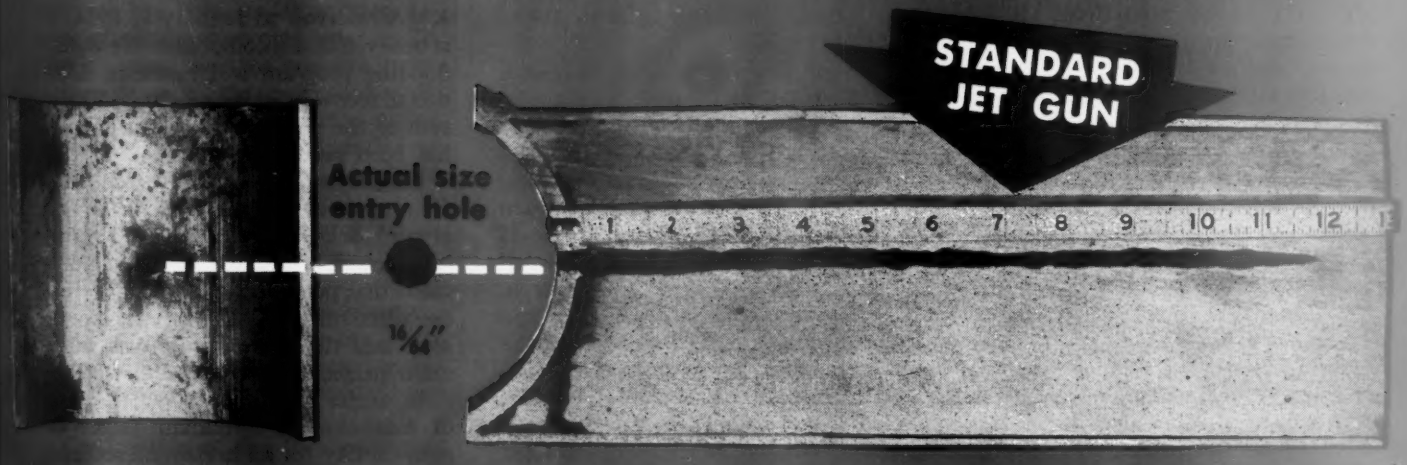

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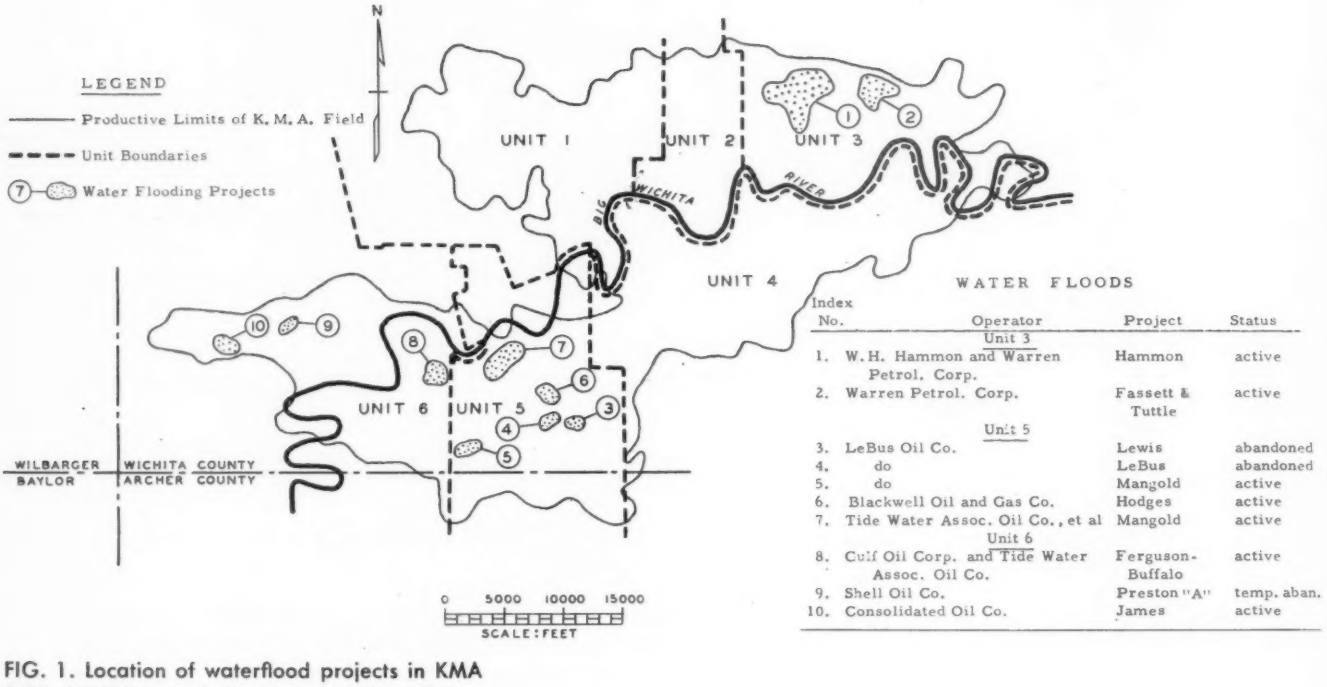
waterflooding activities in the KMA field

R. P. Dobyns, C. T. Burchett, Jr., D. S. McBride, R. R. Darner, and W. H. Hammon



WATER FLOODS

Index No.	Operator	Project	Status
	Unit 3		
1.	W. H. Hammon and Warren Petrol. Corp.	Hammon	active
2.	Warren Petrol. Corp.	Fassett & Tuttle	active
	Unit 5		
3.	LeBus Oil Co.	Lewis	abandoned
4.	do	LeBus	abandoned
5.	do	Mangold	active
6.	Blackwell Oil and Gas Co.	Hodges	active
7.	Tide Water Assoc. Oil Co., et al	Mangold	active
	Unit 6		
8.	Gulf Oil Corp. and Tide Water Assoc. Oil Co.	Ferguson-Buffalo	active
9.	Shell Oil Co.	Preston "A"	temp. aban.
10.	Consolidated Oil Co.	James	active

FIG. 1. Location of waterflood projects in KMA field, Wichita and Archer counties, Texas

STUDY of the results from 10 pilot waterfloods in the KMA field has proved that oil can be moved through the KMA reservoir by injection of water. To January 1, 1954, 174,297 bbl of net waterflood oil has been recovered from 956 acres that have been or are now being waterflooded. A total volume of 5,085,000 bbl of water has been injected into the KMA reservoir through 28 input wells. The production rate (oil or water) of 29 of the 73 producing wells in the flood projects has been affected by the injected water; the lapsed time from the first water injection to the first effect on the producing wells has ranged from 3 to 17 months.

The average daily injection rates currently range from approximately 140 to 400 bbl of water per injection well, the average wellhead injection pressures range from a vacuum to 650 psi, and the average volume of water injected per day per injection well per foot of sand thickness ranges from 1.4 to 10.1 bbl.

Two of the 10 projects are in Unit 3, five are in Unit 5, and three are in Unit 6. The oil-productive part of the KMA formation is comprised of two zones, known locally as Zone I and Zone II. Zone I is being or has been flooded in four projects and Zone II in six projects. Brine is being injected in six of the projects, fresh water in three of the projects, and brine and fresh water in one project. Five of the projects have a closed type water injection system, four have an open type, and one has both an open and closed type. Seven projects are using untreated injection water, one project is using both treated and untreated water, and two projects are using treated water.

Water injection has resulted in a definite increase in oil production from five of the projects, two projects were failures, and three projects cannot be classified as either at this time. Approximately 87,800,000 bbl of oil has been produced from the 30,400-acre KMA reservoir to January 1, 1954. It is believed that a comprehensive waterflooding program will result in additional recovery of as much as 50 per cent of the volume of oil that already has been produced.

Laboratory tests were made on cores from two wells to determine if the reservoir rock had directional permeability characteristics. This work indicated that permeability varied through the circumference of the core specimens and that the directions of maximum permeability in general were at right angles to each other. The ratio of maximum to minimum values of permeability for all horizontal sections tested averaged about 4:3. Further investigations of fluid movements in the entire KMA reservoir will be necessary to determine the magnitude and scope of any directional trend that the injected water may have as a result of directional permeability of the reservoir rock.

Field Before Waterflooding

The KMA reservoir was discovered at a depth of 3719 ft in March, 1931.

†This paper was presented at the Secondary Recovery Symposium of the North Texas section, AIME, sponsored by North Texas Oil and Gas Association, Midwestern University Auditorium, in Wichita Falls, Texas.

EXCLUSIVE

Extensive development of the area was not begun until the latter part of 1937, when a well approximately two miles southwest of the discovery well was completed with an initial flowing production of 2018 bbl of 43 API gravity oil in 12 hours.[1] After this well was completed, the reservoir was developed rapidly until 1609 producing wells had defined a productive area of 30,400 acres.

The KMA reservoir is a complex anticline in the Strawn formation of Pennsylvanian age. In the southwest part of the field (see Units 5 and 6, Fig. 1), the oil productive section of the KMA formation consists of two zones that have been designated locally as Zone I and Zone II. In this area the reservoir rock is composed of sediments that grade from limestone through sandy lime and limey sand to sandstone with thin streaks of shale. The average porosity of each zone in this area is approximately 16 per cent, and the permeability will range from 0 to as high as 2500 md.

The KMA reservoir rock in Unit 3 in the northern part of the field consists principally of one producing zone. This zone can be correlated with Zone II in the southwestern part; but the physical characteristics differ, as the reservoir rock in this area is very uniform, fine-grained sandstone with calcareous cementing material. The average porosity is approximately 14 per cent; and, although the permeability ranges from 0 to 10 md, it probably does not average more than 1 md.

Since January, 1940, the entire KMA reservoir has been under varying degrees of gas-pressure maintenance. To permit control over the pressure maintenance program, the reservoir was divided into six surface areas, called units. The geographic boundaries of these units, as well as the location of the pilot waterfloods, are shown in Fig. 1. The gas injection program in Units 5 and 6 has been more comprehensive than in any other units in the field. Most of the oil wells, however, in Unit 3 have been kept flowing (using intermitters) through pressure maintenance by returning the produced gas to the reservoir.

The location of the 10 pilot waterflooding projects in the KMA field is shown in Fig 1. Two projects are in Unit 3, five in Unit 5, and three in Unit 6. A factual analysis of each is presented in the following sections of this report. Table 1 summarizes pertinent data on the waterflood projects.

Unit 3 Waterfloods

There are two waterflooding projects in Unit 3—the W. H. Hammon and Warren Petroleum Corporation Hammon project and the Warren Petro-

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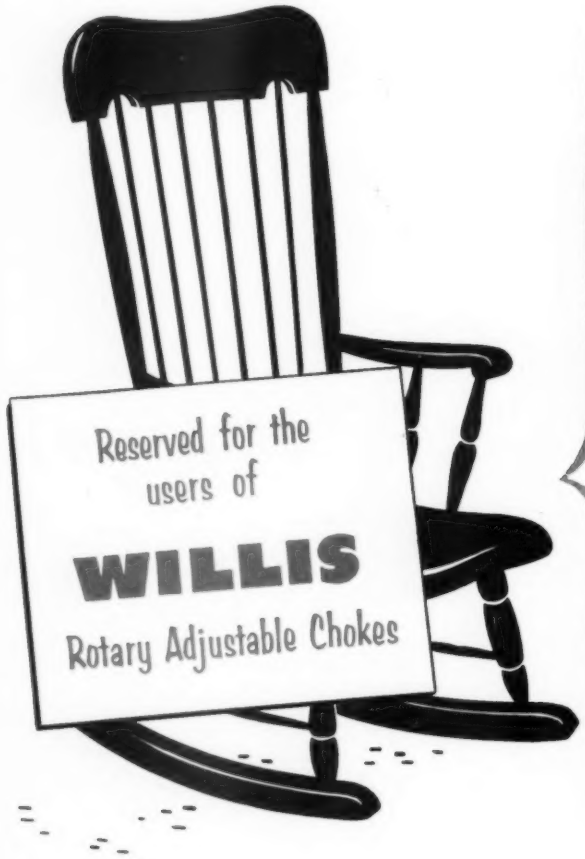
TABLE 1. Salient data on waterfloods in KMA field, KMA reservoir, Wichita and Archer counties, Texas.

	W. H. Hammon and Warren Pet. Corp. Hammon project	Warren Pet. Corp. Fassett and Tuttle project	LeBus Oil Co. Lewis project	LeBus Oil Co. LeBus project	LeBus Oil Co. Mangold project	Blackwell Oil and Gas Co. Hodges project	Tide Water Assoc. Oil Co. et al. Mangold project	Gulf Oil Corp. and Tide Water Assoc. Oil Co. Ferguson-Buffalo project	Shell Oil Co. Preston "A" project	Consolidated Oil Co. James project
Map index number	1	2	3	4	5	6	7	8	9	10
Unit	3	3	5	5	5	5	5	6	6	6
Status	Active	Active	Aband. 1-53	Aband. 1-53	Active	Active	Active	Active	Temp. aband. 12-51	Active
Data on leases in project										
Zone flooded	II	II	II	II	II	II	I	I	I	I
Productive area of leases, acres	1,568	603[1]	147.5	150	480	162[9]	597	753	237	279
Gross productive volume of zone flooded, acre-feet	61,670	25,015[1]	8,482	8,895	31,318	8,944[9]	28,154	34,364	12,321	13,573
Average gross sand thickness of zone flooded, feet	39.3	41.5[1]	57.5	59.3	65.0	55.2[9]	47.1	45.6	52.0	48.6
Production data of leases before water flooding										
Cumulative oil production, barrels	2,878,761	1,104,720[1]	521,326	742,769	1,737,906	789,087[9]	3,343,191	3,281,994	1,045,293	992,149
Cumulative oil recovered per acre, barrels	1,836	1,832[1]	3,534	4,952	3,621	4,871[9]	5,600	4,359	4,411	3,556
Data on flood pattern area										
Productive area of zone flooded, acres	332	144[2]	18.7	24.9	56.4	80.7[10]	183	66	21	29.4
Gross productive volume of zone flooded, acre-feet	15,720	6,020[2]	1,126	1,563	3,445	4,976[10]	10,975	4,140	1,135	1,355
Average gross sand thickness of zone flooded, feet	47.3	41.8[2]	60.2	62.8	61.0	61.7[10]	59.9	62.7	54.0	46.1
Number of producing wells	15	10	5	4	4	6	13	9	4	3
Number of input wells	6	2	1	1	1	2	8	4	1	2
Production and injection data of leases during water flood as of 1-1-54 unless otherwise noted										
Date water injection began	6-50	12-50	9-51	7-51	4-51	4-51	2-52	9-52	12-50	7-52
Date of first oil production increase	11-51	5-51	12-51	10-52[7]	[8]	12-53[7]	6-52	[8]	9-51	[8]
Cumulative lease oil production, barrels	226,905	128,042[1]	7,340[5]	11,292[5]	56,941	27,560[9]	194,605	64,311	40,695[11]	25,165
Cumulative oil recovery per lease-acre, barrels	145	212[1]	50[5]	75[5]	119	170[9]	326	85	172[11]	90
Cumulative water-injected, barrels	988,760	753,869	103,724[5]	178,481[5]	(est.)297,000	(est.)57,700	1,790,626	452,623	147,000[11]	315,171
Cumulative water injected produced oil ratio	4.4	5.9	14.1	15.8	5.2	2.1	9.2	7.0	3.6	12.5
Average water injected per injection well per day per foot of gross sand, barrels	3.8	10.1	4.7	7.4	(est.)9.2	(est.)1.4	5.1	1.8	9.7	8.7
Range of injection pressures, psi	150-350	512-587	430-580[5]	500-650[5]	Vacuum	0-500	Vacuum	0-600	Vacuum[11]	50-100
Cumulative water produced, barrels	9,368[12]	20,950[12]	[6]	[6]	0	[6]	39,291[12]	0	0	0
Volume water injected to date of first response, barrels	267,296	56,471	21,360	156,242	—	[6]	212,762	—	84,000	—
Time from first injection to first response, months	17	5	3	15	—	16	4	—	9	—
Number of wells that have responded to water injection	5	9	2	2	0	1	8	0	2	0
Net water-flood oil recovery as of 1-1-54 unless otherwise-noted										
Total volume, barrels	71,900	42,900[3]	147[5]	0	0	0	57,400	0	1,950[11]	0
Volume per flood-pattern acre, barrels	217	298	7.9[5]	0	0	0	314	0	92.9[11]	0
Volume per lease-acre, barrels	45.8	70.6[4]	1	0	0	0	96	0	8.2[11]	0

[1] Does not include Fassett and Tuttle "G" lease.
[2] Includes part of "G" lease in flood pattern.
[3] Includes an estimated 2200 bbl of net water flood oil produced from Fassett and Tuttle "G" well No. 29.
[4] Includes 4.6 acres of Fassett and Tuttle "G" lease.
[5] Through January 1953.
[6] No data.
[7] Water broke through without increase in oil production.
[8] No increase in oil production to 1-54.
[9] Hodges lease only.
[10] Includes part of Lowry lease in flood pattern.
[11] To 1-1-52.
[12] Estimated from periodic well tests.



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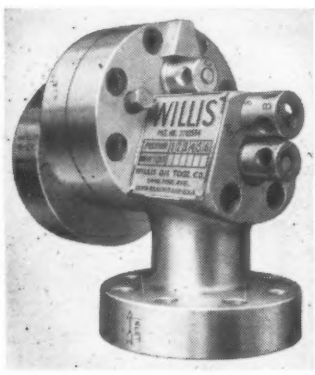
An entire lease is controlled accurately and precisely in a matter of minutes, right from the old rocking chair, through a battery of Willis Rotary Adjustable Chokes.

6 WAYS BETTER FLOW CONTROL



WILLIS Rotary Adjustable Choke provides 6 different sized choke inserts which are individually positioned in the line of flow by a fractional turn of the orifice-carrying disc . . . while under constant flow and high pressure. The 6 graduated orifices are changed to a new range of sizes in minutes . . . without shutting-in the well.

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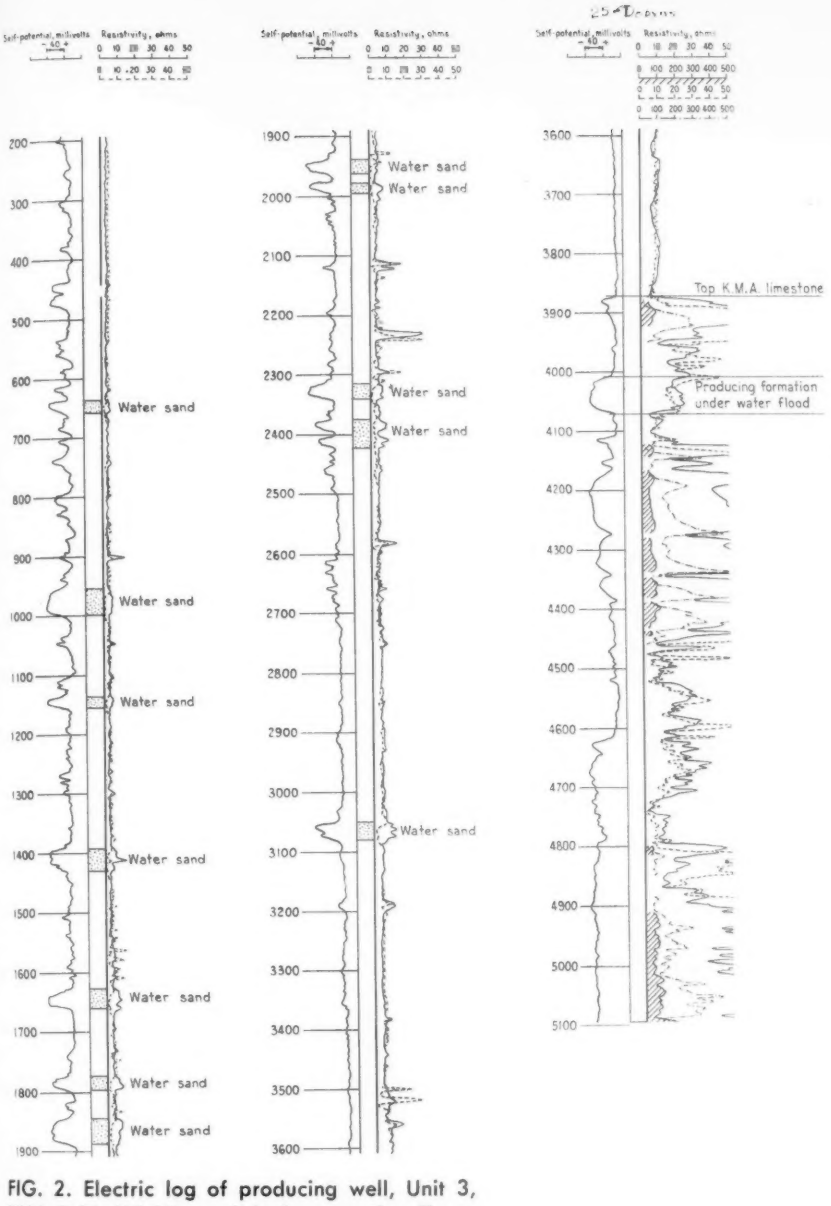

FIG. 2. Electric log of producing well, Unit 3, KMA field, Wichita and Archer counties, Texas

leum Corporation Fassett & Tuttle project (see Fig. 1). Fig. 2 is an electric log from the Warren Petroleum Corporation Fassett & Tuttle "E" well No. 10, which indicates that the area under flood in Unit 3 has only one productive zone. Because of the similarity of the distance between the top of the limestone and the top of the producing formation and the presence of a distinct shale break below the producing formation, this zone probably will correlate with Zone II in the southwestern part of the KMA field. The electric log also indicates that water sands are present from the top of the hole to the top of the limestone. The electric log shows that some porosity is present in the very top of the KMA limestone; because of this, producing wells have been recompleted by gun-perforating this section in certain areas in Unit 3. Two wells on the Fassett & Tuttle "A" lease, seven wells on the Hammon Fee lease, 15 wells on the Fassett & Tuttle "G" lease, and one well on the Fassett & Tuttle "E" lease have been recompleted in this upper limestone. This section is not considered adaptable to waterflooding and is not open to the well bore in any of the wells in the waterflood pattern areas.

Fig. 3 is a structure map contoured on top of the KMA limestone and shows the subsurface configuration of this formation. Although several small highs are evident, in general the limestone dips southeast and ranges in depth below sea level from 2700 ft in the northwest to 2920 ft in the southeast.

Fig. 4 is a structure map contoured on top of the producing section of the Strawn formation waterflooded by W. H. Hammon and Warren Petroleum Corporation. The area under waterflood is indicated by the hachured line connecting either producing or injection wells. The general dip of the formation is southeastward, and the top of the formation ranges in depth below sea level, from 2840 ft in the northwest to 3080 ft in the southeast. One small high and one small depression are evident from the contours.

Fig. 5 is an isopachous map showing the gross production thickness of the section under waterflood. It is evident from this map that the gross productive thickness varies considerably across the leases under waterflood, ranging from less than 20 ft to over 60 ft in thickness. In general, the maximum thickness lies in an east-west trend along the northern and southern edges of the leases, with the thinner section lying along the same trend through the central portion of the leases.

The lithology of the producing zone in the northern part of the KMA field is quite different from that of either of the two producing zones in the southwestern part of the field; the reservoir rock may be described as a fine, uniform sandstone, with calcareous material as the matrix. Analyses of core

TABLE 2. Analysis of core samples from producing zone, unit 3, KMA formation, KMA field, Wichita and Archer counties, Texas.

W. H. Hammon
Hammon Fee well No. 16

Elevation, 1003 feet

Interval from which core was taken, feet below derrick floor		Permeability, millidarcys		Porosity, per cent	Residual saturation, per cent	
From	To	Horizontal	Vertical		Oil	Water
3980	3981	8.7	2.1	16.0	6.8	59.5
3981	3982	3.4	—	15.2	10.6	54.0
3982	3983	0	0	11.9	6.4	46.6
3983	3984	.4	—	11.8	6.6	52.1
3984	3985	.4	.5	12.3	4.6	46.9
3985	3986	.8	—	12.3	6.0	52.1
3986	3987	2.2	2.4	13.6	9.5	50.7
3987	3988	1.0	—	14.4	6.3	51.4
3988	3989	.4	.3	13.1	8.5	45.7
3989	3990	1.0	—	14.1	6.4	47.8
3990	3991	2.4	.6	13.6	6.3	46.0
3991	3992	.8	—	12.3	6.1	53.8
3992	3993	1.5	0	13.6	8.3	52.8
3993	3994	.8	—	12.6	7.5	54.5
3994	3995	4.0	0	11.7	6.5	59.0
3995	3996	8.1	—	13.0	8.6	49.4
3996	3997	2.0	1.5	14.0	7.6	53.0
Weighted average.....		2.3	1.2	13.3	6.8	51.5

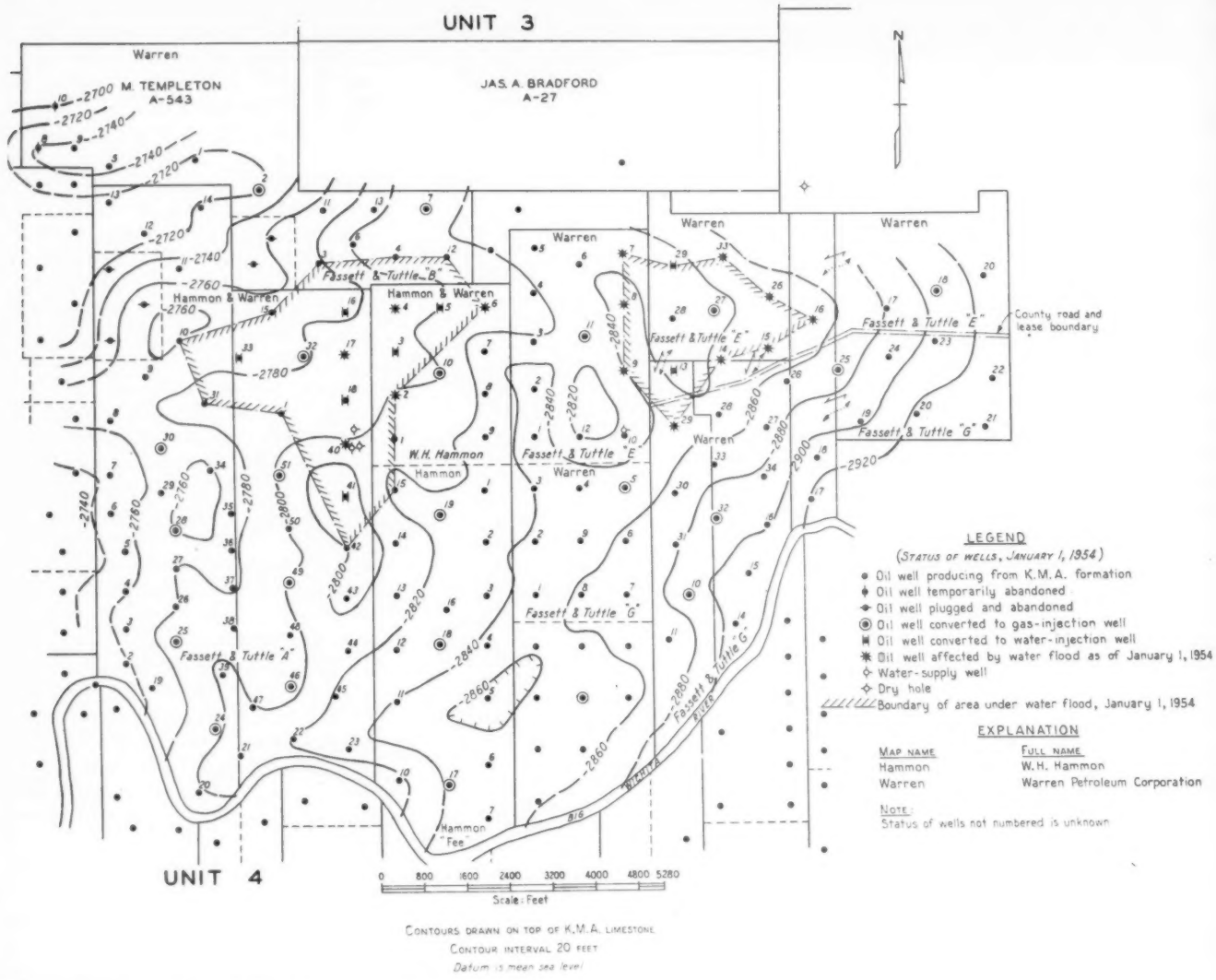

FIG. 3. Structure Map of KMA limestone, Unit 3, KMA field Wichita and Archer counties, Texas

samples of the producing zone taken from W. H. Hammon Hammon Fee well No. 16 are shown in Table 2. Table 3 summarizes analyses of core samples from the producing zone for wells on the Fassett & Tuttle "B," "E," and "G" leases. The permeability of the formation will average approximately 1 to 2 md, which is very low compared with the average permeability in the southwestern part of the field. The average porosity of the formation was calculated to be 14.1 per cent, and the average connate water was estimated to be 30 per cent. Although core analysis data showed that the average permeability was very low, the permeability distribution was fairly uniform, and the range in magnitude from maximum to minimum was not great.

Development of the leases in the two projects was begun when the W. H. Hammon and Warren Petroleum Corporation Fassett & Tuttle "A" No. 1 was completed on October 26, 1937, with an initial production of 182 bbl of oil during a two hour test. This well was shot with 60 quarts of nitroglycerin between 3989 and 4014 ft. Development of these leases, continuing until the productive acreage was completely drilled, was as follows:

Lease	No. of wells	Area, acres	Drilling completed
Fassett & Tuttle "A"....	51	1092	July 1941
Fassett & Tuttle "B"....	13	276	July 1941
Hammon.....	10	200	June 1941
Fassett & Tuttle "E"....	24	603	Jan. 1942
Fassett & Tuttle "G"....	32	706	Dec. 1941

The producing wells were completed by setting and cementing 5½ or 7-in. casing in the interval between the top of the KMA limestone and the top of the producing formation. All wells either were shot with nitroglycerin, acidized, or both. The shots averaged approximately four quarts of nitroglycerin per ft of oil sand. When the waterfloods were begun, all wells were equipped with intermitters and flowed periodically on a set-time schedule, except for a few wells equipped for pumping.

Gas injection was begun in this area when the KMA Pressure-Maintenance Association was organized in January, 1940. The status of the gas-injection wells, as well as the oil-producing wells, is shown in Fig. 3. During December, 1953, an average of 58,800 cu ft of gas per day per injection well was being injected into the reservoir. The input pressure ranged from 220 to 1400 psi and averaged 848 psi. The average daily input volume of individual wells ranged from a minimum of 258 cu ft to a maximum of 186,000 cu ft per well.

W. H. Hammon and Warren Petroleum Corporation Hammon Project

This waterflooding project is composed of the W. H. Hammon and Warren Petroleum Corporation Fassett & Tuttle "A" lease, Warren Petroleum Corporation Fassett & Tuttle "B" lease, and W. H. Hammon and Warren Petroleum Corporation Hammon lease. The Fassett & Tuttle "A" lease is in the

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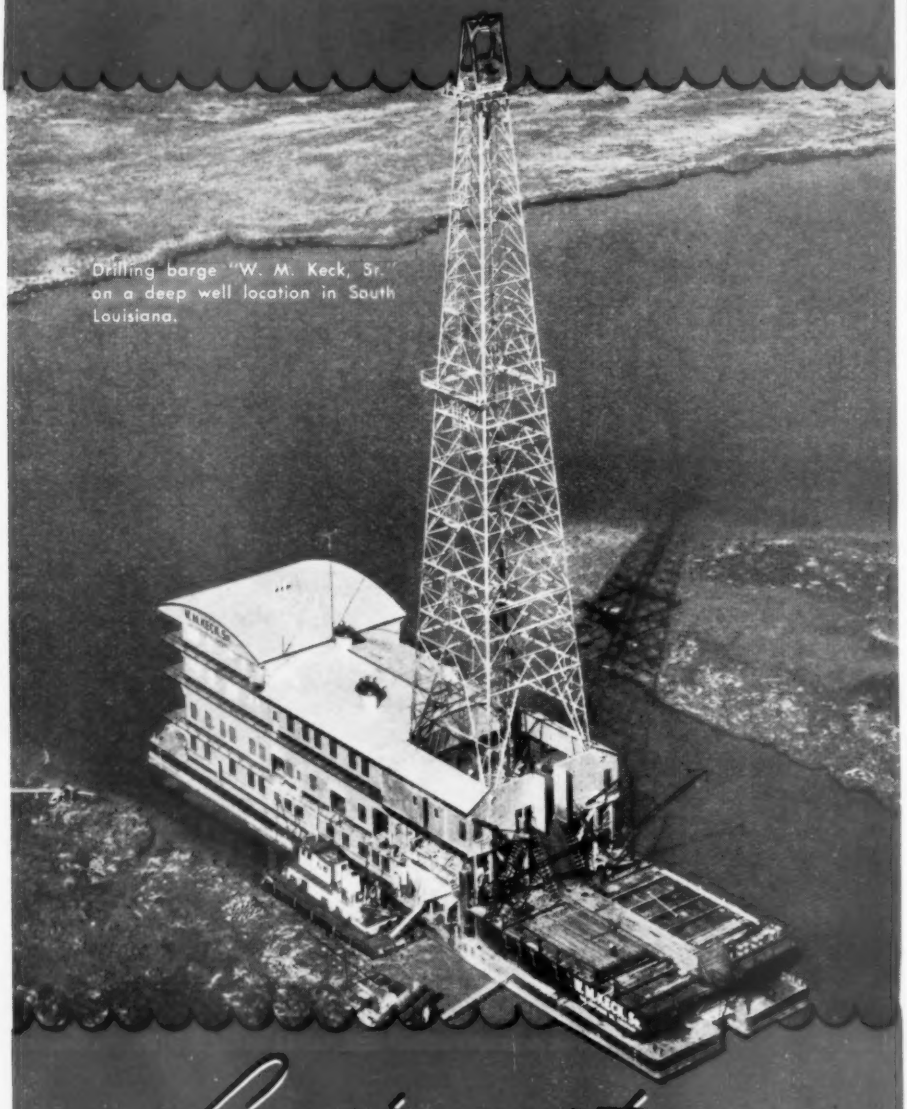

Drilling barge "W. M. Keck, Sr." on a deep well location in South Louisiana.

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Col. Tap RR. survey, abstract 769, and E. T. RR. survey, abstract 76. The Hammon lease is in the E. T. RR. survey, abstract 762. The Fassett & Tuttle "B" lease is in the M. Templeton survey, abstract 543.

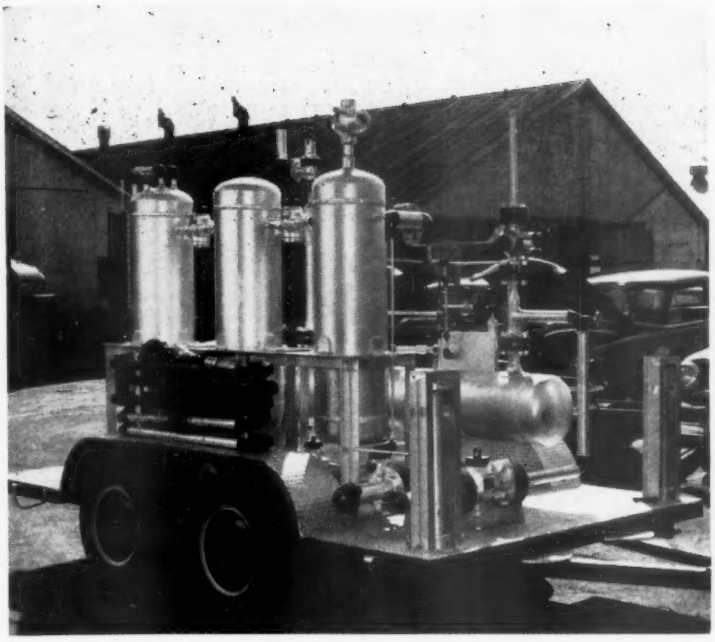
History Before Waterflooding

Fig. 4 shows the location of the oil-producing and water-injection wells on these leases and an outline of the probable limits of the waterflooding area. The productive area of the leases is 1568 acres. The gross volume of the reservoir was calculated to be 61,670 acre-ft, and the average gross thickness was calculated to be 39.3 ft.

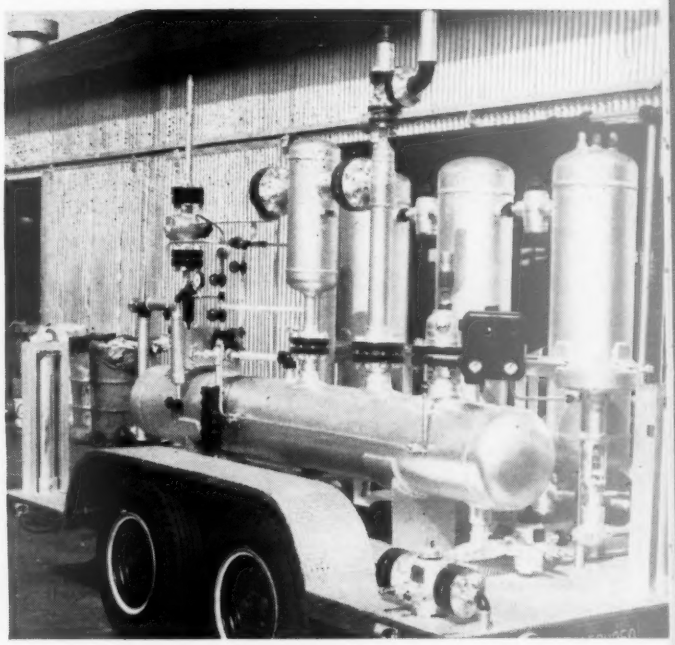
Because the operators were having trouble with the injected gas by bypassing to the producing wells, an attempt was made in 1952 to reduce the amount of bypassing by injecting fresh water into the gas-injection wells. The wells selected for this experiment are as follows: Hammon Well No. 10 and Fassett & Tuttle "A" wells No. 18 and 32. A total of 6750 bbl of fresh water was injected into Hammon well No. 10, 4095 bbl into the Fassett & Tuttle "A" well No. 32, and 1757 bbl into the Fassett & Tuttle "A" well No. 18. The water was injected into the gas-injection wells intermittently by slugs over a period of four months in Well No. 10, two months in Well No. 32, and four days in Well No. 18. The surface pressure necessary for injecting water into these wells ranged from a vacuum to as high as 1120 psi. The gas-oil ratios of the producing wells were reduced by the injection of water, but the increase in oil production was small. Gas injection was resumed in all wells except Fassett & Tuttle well No. 18, which was converted to a waterflood input well approximately two months after the experiment with reducing gas-oil ratios was completed.

The month before waterflooding was begun, 4908 bbl of oil was produced from the 1568 productive acres in the project. The total oil recovery from all the leases in the project before waterflooding was 2,878,761 bbl, or 1836 bbl per acre. The monthly oil production and water injection as well as the number of water-injection wells, is shown graphically for the entire project in Fig. 6. Pertinent oil-recovery and reservoir-volume data are tabulated in Table 1. The percentage of initial volume of stock-tank oil in place, recovered to the start of waterflooding, was calculated to be 13.5 for the Fassett & Tuttle "A" lease, 11.4 for the Fassett & Tuttle "B" lease, 14.7 for the Hammon lease, and 13.3 for the combined leases.

(Part II of series will appear in an early issue.)



Front and side view of unit showing inlet and outlet connections at bottom center with flexible connections mounted over wheel well. Note piping and bracket arrangement of the three accumulator cells and accessibility to valves.



Rear view of the test unit showing portable separator in foreground and three upright accumulators in background. Note piping arrangement and location of component parts for weight distribution.

Portable Tester for Gas-Condensate Wells

Trailer-mounted full scale tester provides useful tool for production tests of high pressure wells under restricted flow conditions

Don Attaway

THE constantly expanding completion of high pressure gas-condensate wells throughout Arkansas, Louisiana, and Texas has created a testing problem for the many operators and natural gasoline plants who are producing or processing this gas.

Usually such gas wells are tied into the field gathering lines of plants operating in the area and the entire well stream produced into the line. This is a simple and economic solution to the operator as it relieves him of the necessity of installing high pressure separators, tank batteries, and finding an outside market for his fluid production. Fortunate, indeed, is the producer who finds a gas company operating a natural gasoline plant in his area to which he can sell his gas at a fair and equitable price as well as the extracted products and the liquid production of his well.

A common practice between producers and processors is to allocate a percentage of the actual plant production to the well owners based upon the potential recoverable hydrocarbon content of their gas. In order to do this, each well tied into the plant must be tested at regular intervals by a practical and reliable method to determine its theoretical content.

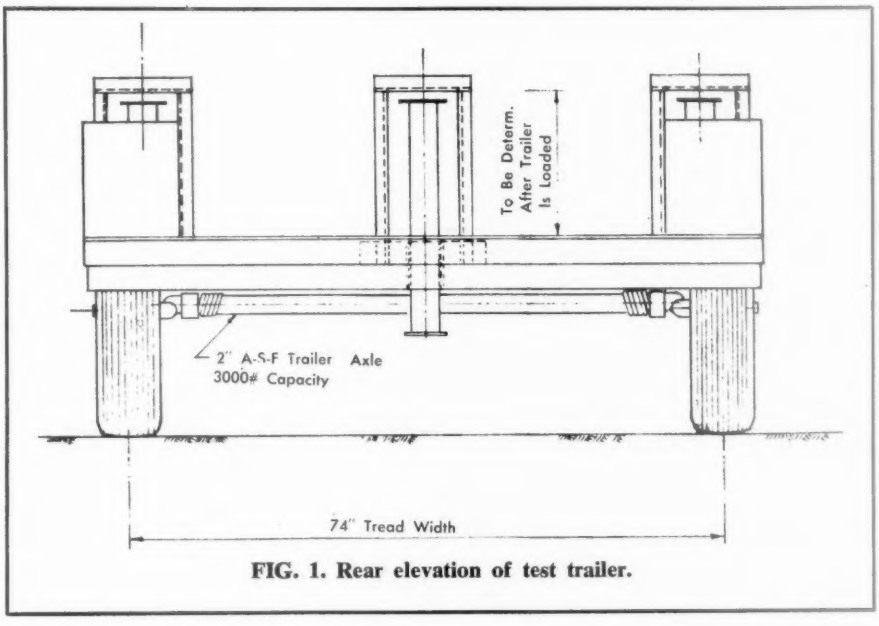


FIG. 1. Rear elevation of test trailer.

EXCLUSIVE

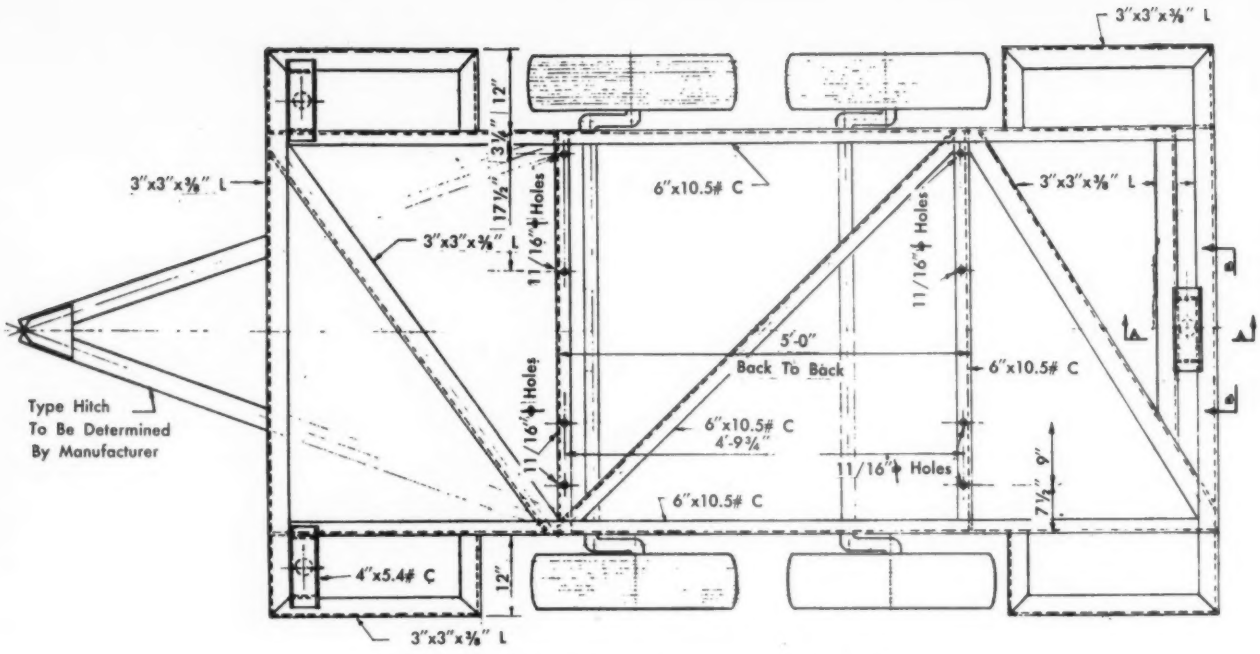


FIG. 2. Plan of trailer showing construction details.

In the January, 1954, issue of The Petroleum Engineer, the author described one method of testing two-phase gas streams for liquid hydrocarbon contents. This "split-stream" or "stinger" test method has a minimum flow rate application in the vicinity of 1,500,000 cu ft daily. Gas wells prorated to flow rates lower than this or unable to operate at this minimum must be tested by other methods. This is especially true of wells flowing erratically, such as "slugging" or "heading."

In order to secure liquid hydrocarbon content tests on high pressure gas wells having the above characteristics, the Arkansas Louisiana Gas Company of Shreveport, Louisiana, adopted the full-scale separator test as its method. A review of the portable full-scale separators on the market by manufacturers found none that exactly suited the conditions. First requirement was a working pressure in excess of the usual factory fabricated unit. Furthermore, variable back-pressure control and regulation equipment was desired as well as complete water, oil, and gas separation. In addition liquid capacity of the conventional models was too low for many applications. Many other features were desired such as calibrated direct fluid readings instead of liquid metered volumes, extreme mobility in the field, complete unit leveling, means of returning the fluid samples into the high pressure gas line, and flexible test connections.

After considerable study of the requirements and many experimental designs, a final set of specifications were agreed upon and the construction started in the National Gasoline De-

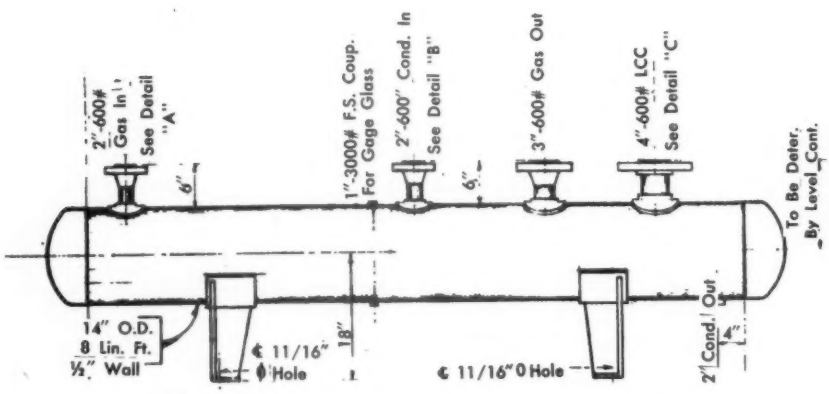


FIG. 3. Details of horizontal high pressure separator.

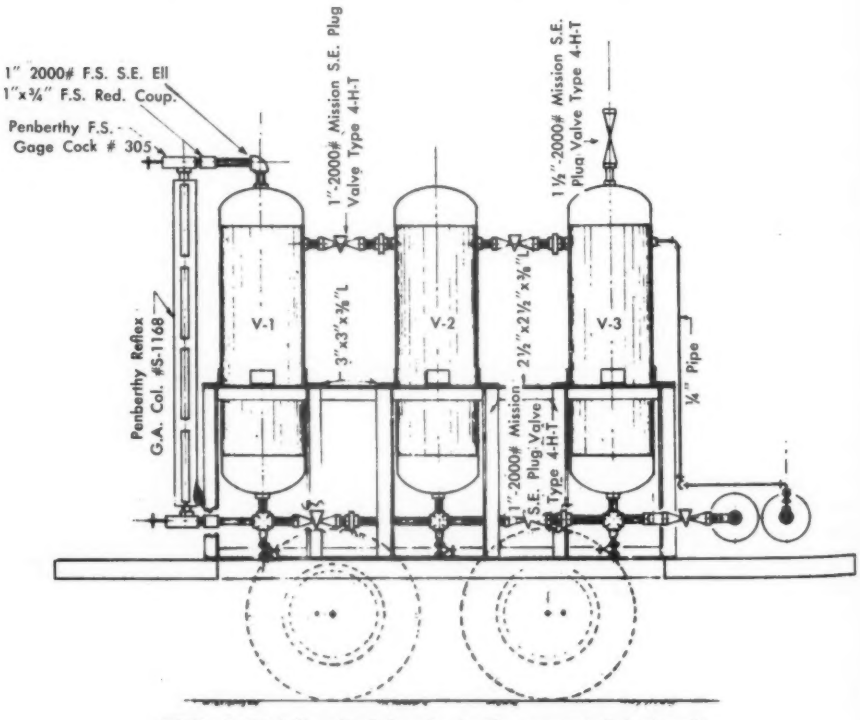


FIG. 4. Details of piping in trailer mounted test unit.

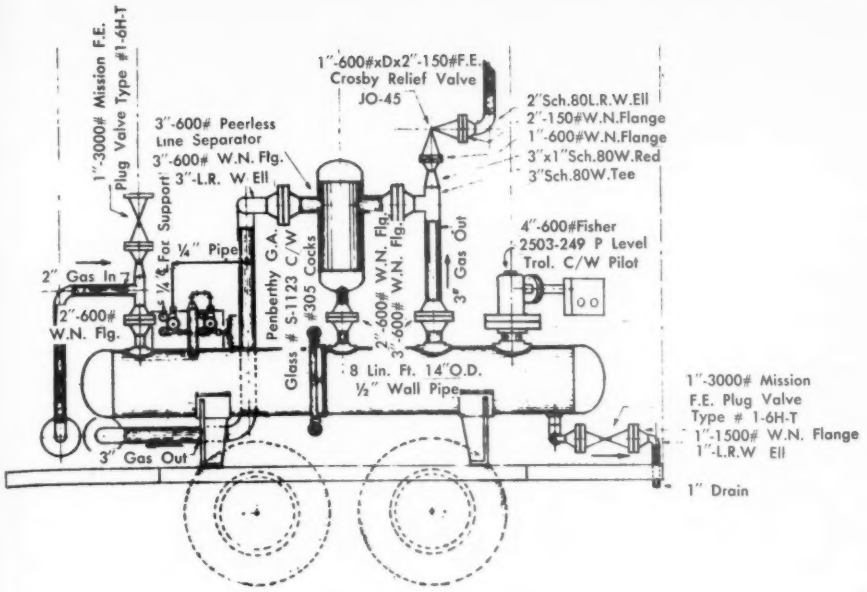


FIG. 5. Details of piping.

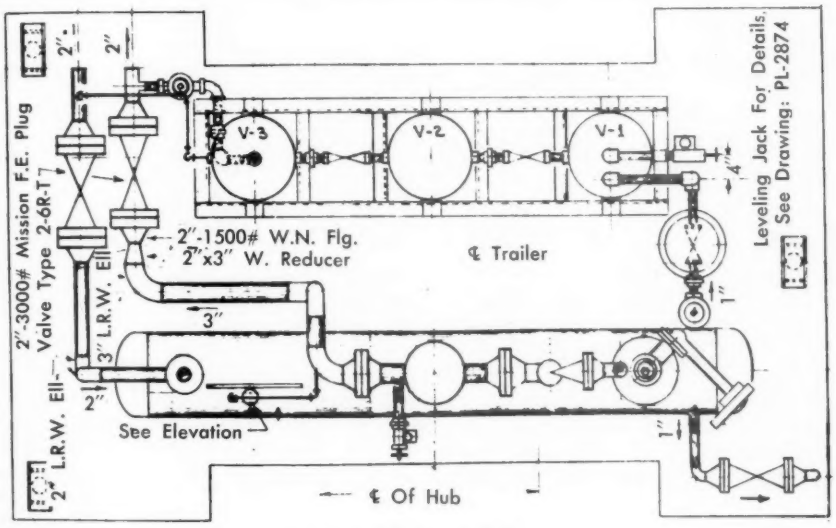


FIG. 6. Details of piping.

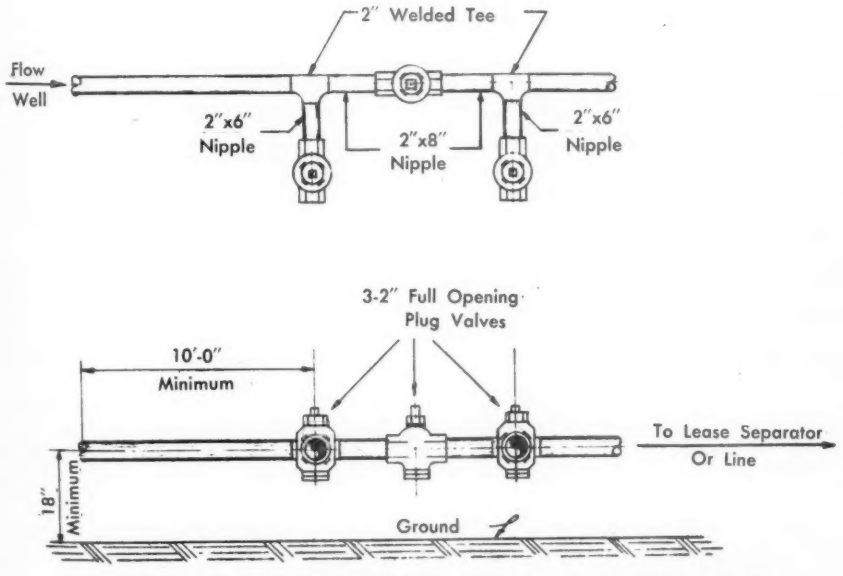


FIG. 7. Detail of individual well requirements for attaching test unit.

partment utilizing their personnel for engineering and fabrication.

First, a double-axel "level load" trailer utilizing spiral spring leverage action rather than the standard elliptical leaf spring was secured. This four-wheel trailer was equipped with electrically operated braks. Such a trailer reduces side-sway or load shift and diminishes road shock to provide a cushioned effect and protect the more delicate equipment to be mounted in the the unit. The trailer platform was fabricated of channel iron and made 11½ feet long and 7 ft wide, as shown in Fig. 2. Leveling jacks were located at the two front corners and the rear center as shown in Fig. 1. The trailer was then floored with ¼-in. floor plate for rigidity and to bear the weight of the vessels.

The horizontal separator shown in Fig. 3 was fabricated from 14-in. line pipe having a ½-in. wall thickness to operate at 2000 lb working pressure and mounted in saddles.

The three identical accumulators were fabricated from the same type pipe as the separator and mounted in a support bracket assembly made from ⅜-in. angle iron.

The unit was piped as shown in the detailed Figs. 4, 5, and 6, with a 2-in. gas inlet and a 3-in. gas outlet. By the use of swivel joints, a bank of inlet and outlet flexible piping was mounted over the wheel well in a bracket. Adequate safety valve relief was provided as well as bleed and drain valves.

Upon complete assembly, the unit was provided with a trailer hitch, proper tail and clearance lights before painting aluminum and trimming in black. The total weight of the unit is approximately 7000 lb.

In order to use this portable full-

SPECIFICATIONS

1. **Working pressure of block, valve, side connections, and piping to be in compliance with anticipated pressures.**
2. **Valves to be located down stream from choke.**
3. **Preference given to location ahead of any heaters or separators.**
4. **Location must be accessible for trailer mounted test separator.**
5. **Full scale separator tests are desirable on all wells having flow rates lower than 1500 MCF daily.**

FULL SCALE SEPARATOR TEST CONNECTION

scale tester in the field, each well falling within its testing category had to be equipped with an installation of block and side valves as shown in Fig. 7. This test assembly was located downstream from the well choke and ahead of any heaters or separators. Consideration also was necessary in the location to provide accessibility of the trailer mounted unit.

The mechanics of testing are fairly simple, but require proper preparation of the well before starting the test. The first requirement is that the well must have been on the line at least 24 hours or more previous to the test. It is highly desirable that the well be operating in its normal characteristic manner at the time of the test. Usually this means that the flow rate, pressure and temperature has not fluctuated widely during the previous 24 hours and that at the very time of the test it will be operating at the conditions anticipated for the immediate future.

This is usually determined by the tester by observing the meter station on the lease where he is able to secure exact data relative to the well's behavior for the past few days as most of the leases are equipped with 7-day chart, clocks and recording temperature instruments.

The test unit is usually hooked into the flow line at the test connection or block gate arrangement and allowed to pass the entire well stream for some time until temperatures and pressures equalize and all working parts are operating freely and correctly.

Once all readings and conditions are taken and stabilized, the unit is checked on at a precise time and the accumulation test started under known conditions. The length of the test can vary from 8 to 24 hours depending upon the behavior of the well. Under a uniform, constant flow, accurate results can be obtained in a short period. A flow made up of "heads" or "slugs," however, requires a much longer test in order to secure representative cycles and a series of peaks or upsets. Usually a 24-hour period will provide sufficient information, unless the flow rate is a rapidly declining one in which case, the test may continue until a stabilization is reached or the flow ceases. By means of the three accumulator cells, any number of test runs or checks can be made.

Sometime during the test, usually as soon as the tester is satisfied with the the operation of the unit, a sample of the outlet or tail gas is diverted through a charcoal test meter to determine the natural gasoline content.

All information is compiled on a full-scale separator test data form. From these factors can be secured the exact amount of gas that passed during the test as well as the true condensate or fluid recovered. At the same time, the tester can weather or flash the fluid sample to atmospheric conditions and secure a shrinkage factor by which a result expressed in equivalent lease tank recovery can be obtained.

It is also possible to directly read the water accumulation or measure it by draw-off or liquid meter. Often samples of the water are obtained to provide the laboratory with material for determining salt content.

At the conclusion of the test, the accumulated fluid recovered may amount to quite a few gallons, sometimes 100 or more. In order to conserve this, a pressure drop can be produced across the unit and the fluid forced out the bottom of the accumulator through the gas outlet and back into the gas gathering line.

The tester delivers his charcoal sample to the nearest plant laboratory where it is distilled and the results computed. At the sample time he may have the water sample analyzed and equipped with this information; he can now furnish a comprehensive report on his well test that provides not only information for the company accounting department but also useful facts for the production engineers and gasoline plant supervisors. * * *

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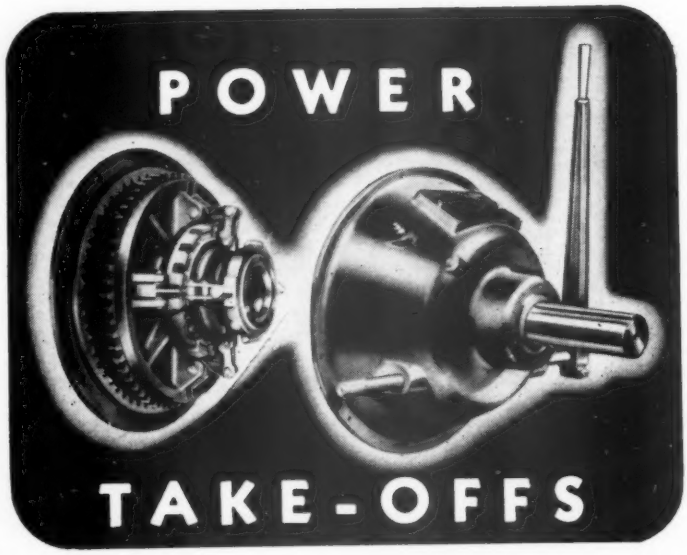

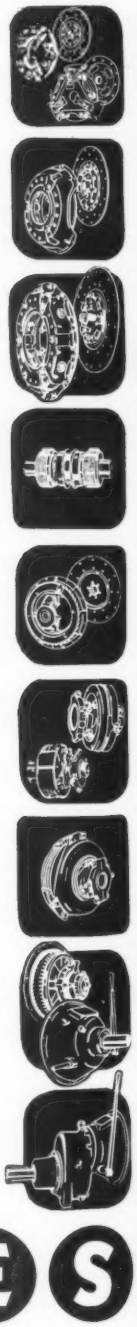

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CLUTCHES

CEMENTING PROCEDURES AND MATERIALS

Dwight K. Smith*

OIL well cementing is basically the process of displacing a cement slurry down the casing and up the annular space behind the pipe where it is allowed to set, thus bonding the casing to the formation. This technique is known and practiced wherever oil wells are drilled. It is a skilled operation which requires special equipment and trained personnel. The life of any successful producing well may depend on a good cementing job.

In drilling for oil it is necessary to pass through various types of formations. These may be permeable zones that contain oil, water or gas. These fluid-bearing formations must be segregated from one another to prevent the migration of gas or fluids up or down the hole. This is accomplished by pumping cement slurry into the annular space between the formations in the well and the casing. When allowed to set, the cement will form a barrier against movement behind the pipe.

Oil well cementing serves other purposes including:

1. **Bonds the pipe to the formation.**
2. **Protects the oil-producing zones.**
3. **Protects other formation strata such as fresh water, coal, potash, and etc.**
4. **Helps to prevent blow-outs from high pressure gas zones behind the casing.**
5. **Protects the casing from corrosive formation waters or electrolytic action.**
6. **Seals against contamination of fresh water zones that may be used for domestic supply.**
7. **Cementing seals off "lost circulation zones" or other troublesome formations in order to drill deeper.**

Generally speaking, cementing procedures may be classified as "primary" and "secondary." Primary cementing involves the problems of lost circulation while drilling, and the cementing of casing after the producing formations have been located. Primary cementing is referred to as the original cementing operation which is performed immediately after the pipe has been run into the hole.[1]

Any repairs or work-over jobs requiring the use of cement after completing the primary cementing job may be classified as secondary or remedial cementing. This would include all types of squeeze cementing jobs or other remedial measures used to stop the flow of water into the well, control gas-oil ratios, or to overcome certain other conditions which may exist in the producing well.

Primary Cementing

There are three principle types of casing strings used in rotary drilling.[2]

Surface Casing is set and cemented to protect fresh water zones; to guard against possible cave-in of the surface formations, and to provide for initial drilling control.

Intermediate or Protection Strings are set inside the surface pipe to protect the hole. One or more such strings of pipe may be set.

Oil Strings are set for completing the well as a producer or to test the well production.

Another type of casing job which should be included under primary cementing is that called a liner job. A liner is a pipe similar to casing which is placed through the uncased portion of a well, but it does not extend through the intermediate string to the ground surface. This is a special operation common to many areas and requires a special liner setting tool run on the end of a drill pipe or tubing to allow placement of the pipe in the well.[3]

The cementing operations on any of the previously mentioned jobs are very similar with the possible exception of the liner job. The casing, as shown in Fig 1, is run to the desired depth. Attached to the casing are necessary devices such as floating equipment, centralizers and wall cleaners which have been assembled at the surface.

The floating equipment normally consists of a guide shoe and float collar (Fig. 2) which are assembled at the bottom of the casing. The guide shoe is a rounded nose device that is placed on the bottom of the casing to guide the pipe as it is being lowered into the hole. The float collar is placed some few feet above the bottom of the pipe to act as a back pressure valve and to reduce the weight of the casing on the derrick as it is placed in the well.

Casing centralizers (Fig.3) are equipment used to position the pipe in the hole so that the cement will uniformly fill the annular space around the casing. Wall scratchers or cleaners (Fig. 3) may be of various types or designs but all are used to improve the bonding properties of the cement to the formation by removing the drilling mud filter cake from the bore of the hole. When using scratchers, the pipe is either rotated or reciprocated while circulating drilling mud throughout the system. Oftentimes operators

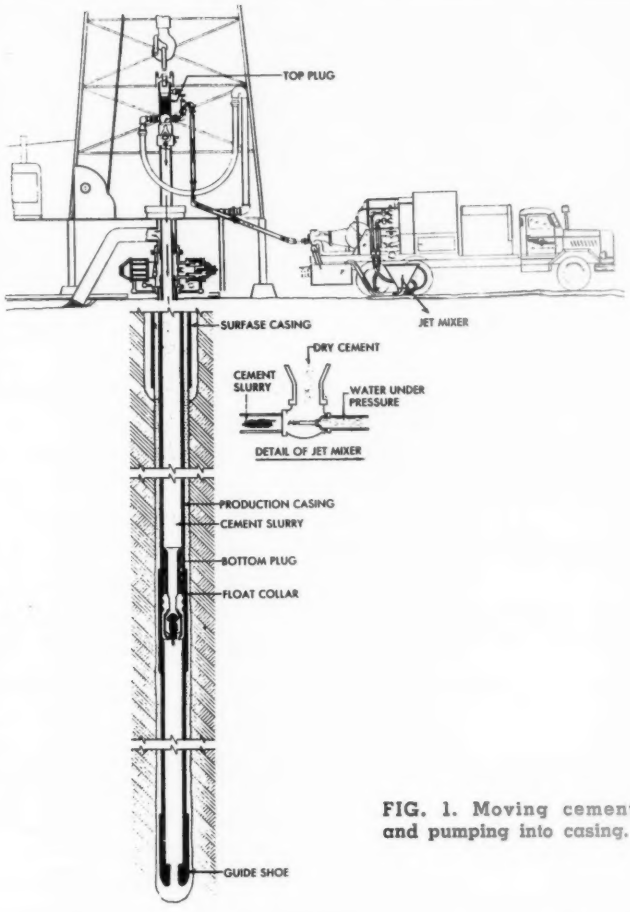

FIG. 1. Moving cement and pumping into casing.

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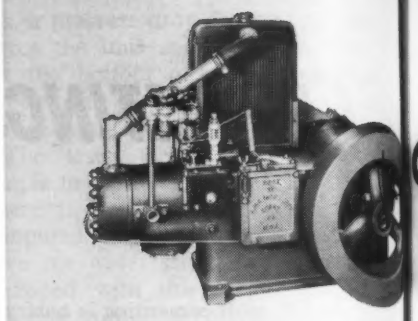

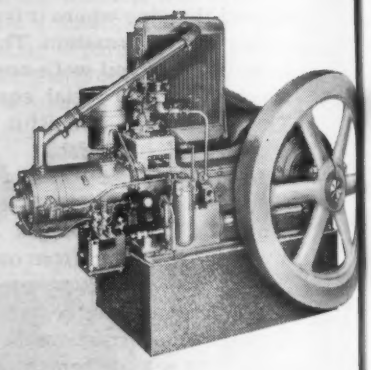

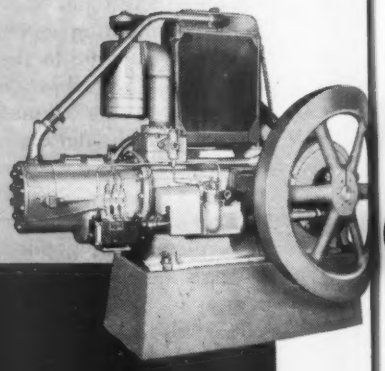

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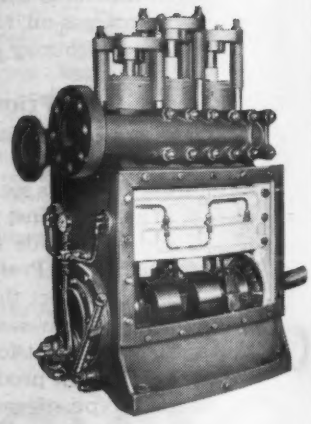

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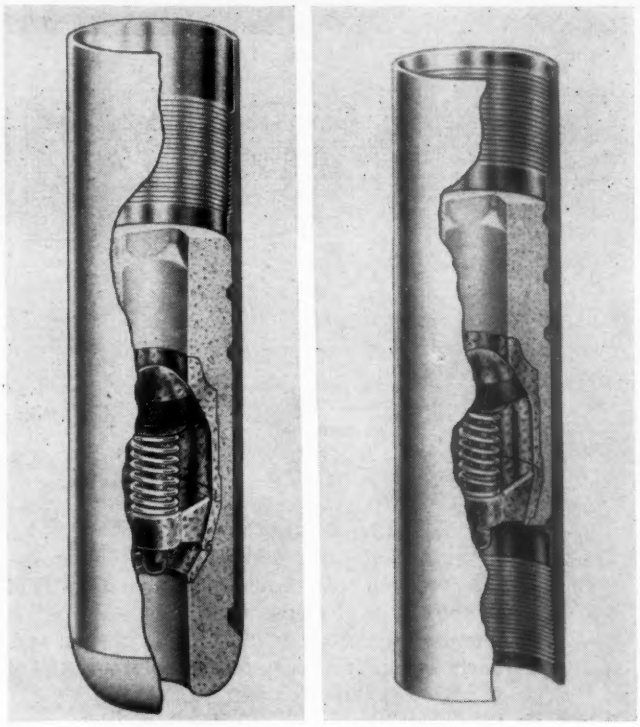

FIG. 2. Guide shoe, left, and float collar.

desire a water wash or a chemical wash ahead of the cement job to remove thickened mud, to reduce channeling and to insure a better bond of the cement to the formation.

In mixing and pumping cement slurries into the well (Fig. 1), the dry cement is normally hauled to the well site in bulk form. During the cementing operation a bulk cement truck discharges cement into the hopper as shown beside the cementing truck. Water is circulated under pressure through a jet located in the base of the hopper which carries the cement in slurry form to the tank or sump tub beside the truck. Control over the slurry weight is maintained by use of a by-pass valve on the pump truck. The cement slurry is picked up from the sump tub with another pump and displaced up to the well head and down the casing.

At the beginning of the cementing job the casing and hole are filled with drilling mud. To prevent contamination on the interface between the mud and cement, a rubber plug (Fig. 4) is pumped ahead of the cement slurry. This plug is released from the plug container located at the top of the casing at the proper time and actually wipes the casing clean as it moves down the pipe.[4] When this plug reaches the float collar the differential pressure ruptures the rubber diaphram at the top of the plug and allows the cement slurry to proceed down through the plug and floating equipment and up the annular space behind the pipe.

At the completion of the cementing operation a top rubber plug is released from the plug container. Its function is to prevent any cement contamination with the fluid that is used to displace the cement column down the casing. The top plug is solid and the design is such that when it reaches the first or bottom plug at the float collar it causes a complete shut off of fluids being pumped into the casing.

Landing of the top plug will prevent any further displacement of the cement slurry and provides good cement around the bottom of the casing where a good bond is required. After allowing the cement to set, the float collar and cement remaining in the lower joints of pipe are usually drilled out.

The interval between the cementing job and the resuming of normal operations is commonly referred to as WOC time or "waiting on cement." This time will depend on type of job, depth, bottom hole temperature, and strength the cement must develop to hold the casing in position.

Often a temperature survey is made within a few hours after the cementing job to ascertain the height to which the cement has reached behind the casing. This is possible because cement, as it sets, gives off a considerable amount of heat. By measuring the temperature of the fluid in the casing, it is possible to locate the top of the cement behind the pipe. By comparing the actual fill up against the total volume of cement used, the actual percentage of fill up can be predicted for adjoining wells.

Secondary Cementing

Perhaps the most common operation under secondary cementing is that which is called a "squeeze job." The term "squeeze cementing" is the physical process of applying hydraulic pressure to force or "squeeze" a cement slurry into permeable space of an exposed formation or through perforations of the casing or liner.[5] This technique generally requires high pressures and is usually performed through a packer arrangement which is set above the point where the cement is to enter the perforations or formation.

The packers used in squeeze cementing may be either drillable or retrievable. The retrievable packers can be released and removed from the well after sufficient squeeze pressure has been applied to the cement slurry. The drillable packers can only be removed by drilling out after performing the job.[6]

Squeeze cementing may be used to remedy such problems as (1) high gas-oil ratios; (2) excessive water; (3) repair of casing leaks or perforations improperly placed; (4) isolation of producing zone prior to perforating for production; (5) remedial or secondary cementing to correct a defective condition such as channeling or insufficient cement on primary cement job, etc.; (6) sealing off low pressure formation that "engulfs" oil, gas or drilling fluids;

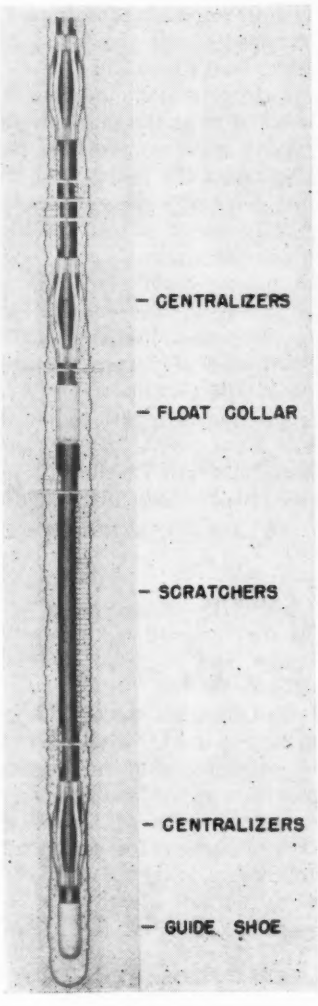

FIG. 4. Rubber cementing plugs.

FIG. 3. Cementing devices.

(7) abandonment of depleted producing zones to prevent fluid migration and contamination of other zones or wells.

Another operation under secondary cementing is that referred to as a plug back job. This simply is the placement of a cement plug at the desired point in the well and allowing it to set up. A plug back operation is normally used in oil wells to shut off bottom hole water or to reduce the hole depth in order to produce from an upper formation. A plug back job may also be employed to "whipstock" or change the direction of drilling.

Cementing Materials

The basic materials that go into the manufacture of cements are the same whether it is used for construction work or for oil well cementing. Cement is produced from a properly proportioned blend of limestone and clay which is composed primarily of compounds of silica, lime, alumina and iron oxide. These raw products are intimately ground and passed through a rotary kiln where they are calcined into a material called "clinker." The clinker is reground into a fine powder to which is added small quantities of gypsum to control the setting properties of the cement.

The final product, known as portland cement, contains chemical compounds of silicon dioxide, calcium oxide, iron oxide, aluminum oxide, magnesium oxide and sulfur trioxide. These basic compounds are:[7]

Tricalcium Silicate	$-C_3S$
Dicalcium Silicate	$-C_2S$
Tricalcium Aluminate	$-C_3A$
Tetracalcium Aluminoferrite . .	$-C_4AF$

which react with water to form set cement.

Cement that is used in oil wells today is subjected to a range of conditions from shallow wells having temperatures of 80 F or lower, to wells whose depths exceed 18,000 ft where bottom hole temperatures are approximately 400 F. The use of a single type of cementing material to fit these wide variations of temperature and pressure conditions is impossible, therefore, different types of cements must be compounded for this wide range in well conditions.

The first property of a cement slurry that should be considered is what is commonly referred to as the pumping or thickening time. A cementing slurry must remain fluid for sufficient time to allow pumping down the casing and up the annular space behind the pipe. A suitable cement should possess an adequate safety factor in case of an unavoidable shut down while pumping the cement slurry.

Secondly, the cement, after having been placed in a well, must set in a reasonable period of time and should develop sufficient strength for continuation of normal drilling operations. The strength required of cement before resuming operations will vary with different operators. According to work by Farris,[8] the minimum strength required for primary casing cement job is 8 psi tensile strength, or approximately 100 psi compressive strength. Because these strength determinations were obtained under ideal conditions, many operators consider 500 psi strength necessary for resuming rig operations.[9]

Types of Cement

The cements used in oil wells are classified as high early strength, common portland cement, and retarded cement. The API Committee on oil well cements, has further classified the cements used in wells and suggests the depths to which the various classifications may be used.[10] These depth limits are based on conditions of casing well simulation tests and should be considered only as approximate values.

The API Committee on Standardization of Oil Well Cements recommends six classes of cement for use in oil fields. These are classified as follows:

Class A: Intended for use to 6000-ft depth*, when special properties are not required. Similar to ASTM C 150, Type I Cement.

Class B: Intended for use to 6000-ft depth*, when sulfate resistance is required. Similar to ASTM C 150, Type II Cement.

Class C: Intended for use to 6000-ft depth*, when high early strength is required. Similar to ASTM C 150, Type III Cement.

Class D: Intended for use to 12,000-ft depth*, when moderately high temperatures and high pressures are encountered.

Class E: Intended for use to 14,000-ft depth*, when high temperatures and high pressures are encountered.

Class F: Intended for use to 16,000-ft depth*, when extremely high temperatures and extremely high pressures are encountered.

*The depth limits are based on the conditions imposed by the casing well-simulation tests, API RP 10B, schedules 1-10, inclusive, and should be considered as approximate values.

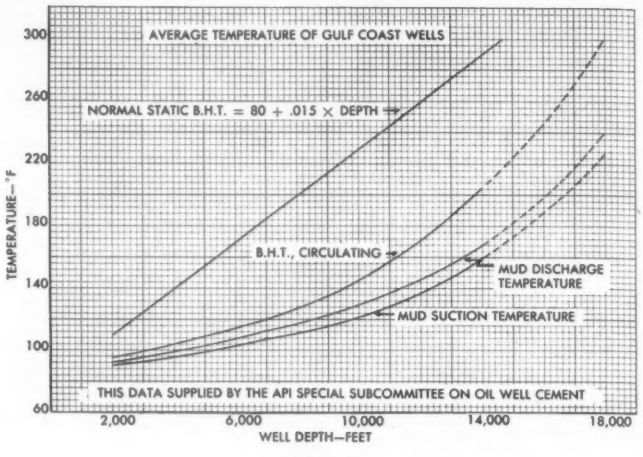

FIG. 5.

Testing of Oil Well Cements

In recent years major advancements have been made in the testing of cements and admixtures used in wells. The development of high pressure testing equipment, such as the Stanolind thickening time tester, makes possible the testing of oil well cements under simulated pressures and temperatures encountered in actual well operations. Such tests give an accurate record of how long a cementing slurry will remain fluid when pumping under these conditions.

Standard procedures for testing cements for various well depths are given in the API RP 10B "Recommended Practice for Testing Oil Well Cements." The casing cementing test schedules of this code are based on actual well data. In the curve in Fig. 5, the normal static bottom hole temperature line is calculated from the formula 80 + .015 × depth in feet. This is taken to be the average formation temperature at various depths along the Gulf Coast and is usually found comparable to those of other areas where wells exceed 10,000 ft. In many areas, of course, there may be exceptions to this average, particularly in shallow wells, but the information given here should be a guide where bottom hole temperatures are not available.

The bottom hole temperature, circulating curve was derived from actual measurements made while wells were being circulated. This is the temperature cement slurry should reach during casing cementing at the given depths. The vertical difference between this curve and the static bottom hole temperature curve represents the amount of cooling a well undergoes while circulating.

The mud discharge temperature curve is the average temperature of the "mud returns" at the surface while circulating. The vertical difference between this and the bottom hole temperature, circulating curve, represents the

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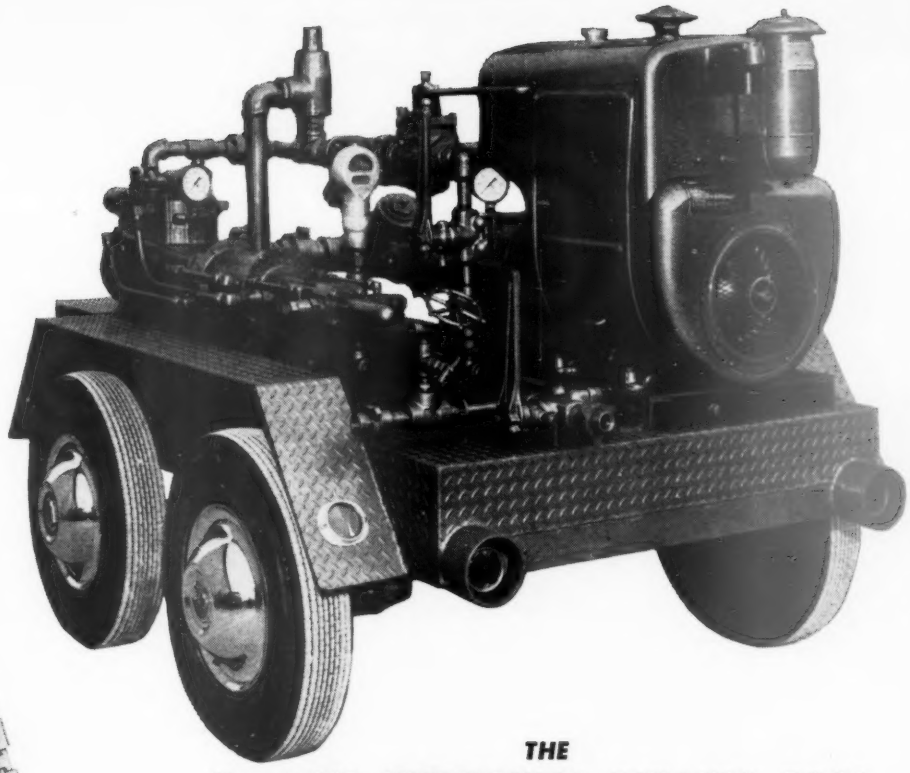

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cooling a slurry undergoes in returning to the surface from the bottom of the well.

The mud suction temperature curve is the average temperature of mud entering the well through the mud pump. The vertical difference between this and the mud discharge temperature represents the cooling a fluid undergoes while passing through the mud pits during circulation.

These curves represent average measured values to the 14,000-ft depth as shown by the solid lines. The dashed part of the curves at depths below 14,000 ft are merely extrapolations of the data gathered above 14,000 ft.

As an example, from the curve, the average 10,000-ft well should have an actual formation temperature (under static conditions) of 230 F. After circulation has been established and conditions stabilized, the bottom hole circulating temperature will be approximately 144 F and the discharge mud temperature will be approximately 127 F.

These curves indicate that the bottom hole circulating temperature of wells is much closer to the mud discharge temperature than to the actual formation temperature. This is especially true of wells that are less than 12,000 ft deep.

Admixtures to Cement

Often it may be necessary to alter or modify the cements used for a particular job to comply with certain well conditions. Today the different types of additives used in cements for various purposes may be classified thus:

Cement Accelerators:
1. Calcium chloride
2. Sodium chloride

Cement Retarders and Dispersants:
1. Calcium lignosulfonates

Light Weight Additives:
1. Bentonite
2. Pozzolans
3. Expanded Perlites
4. Hydrocarbons

Weighting Materials:
1. Barium sulfate
2. Ferrophosforus

Lost Circulation Additives:
1. Shredded fibrous materials
2. Cellophane flakes
3. Mica flakes
4. Expanded Perlites
5. Granlated nut shells

Special Cements:
1. Resin cement
2. Diesel oil cement
3. Gypsum cements

Handling of cement with modern bulk equipment makes it possible to add these materials to the dry cement prior to the actual cementing operations. However, there may be occasions where additives such as accelerators are added directly to the mixing water before cementing.

Cement Accelerators

An accelerator is often used to reduce the waiting time on cement. This is particularly true on surface pipe where it is desirable to resume normal drilling operations as soon as possible after cementing. It is common practice to use calcium chloride for this purpose since it is perhaps the most effective accelerator known for oil well cementing slurries and is readily available and rather economical.

Two per cent calcium chloride based on the weight of the cement or cement mixture will, (a) accelerate the thickening time, (b) accelerate the setting time, (c) increase the early strength, (d) reduce the waiting on cement time. As a rule of thumb, two per cent calcium chloride will approximately double the strength of portland cement at temperatures of less than 120 F in 24 hours. The use of greater quantities will not achieve any beneficial results.

Sodium chloride, when used in approximately the same quantities as calcium chloride, will also cause an acceleration in the setting time. Sodium chloride, however, is not as effective as calcium chloride and should only be used where calcium chloride is not available. Salt water will have the same effect when the sodium chloride concentration is from 40,000 to 60,000 parts per million. A normal concentration of Gulf water will range from 15,000 to 30,000 parts per million of sodium chloride.

Cement Retarders and Dispersants

Some of the more effective cement retarders and dispersants in use today are derivatives of lignin compounds and are generally referred to as calcium lignosulfonates. These are used to retard common portland cement where well conditions are beyond the range normally recommended for this type of cement. In some instances they have been used with retarded cements to give an extension of the thickening time for use in extremely hot wells.

The amount of retarder will depend, of course, on the bottom hole temperature of the well and can be added either to the cement in a dry form or to the mixing water. These materials are also used with high percentages of gel or bentonite cement to achieve a lower viscosity slurry which is easier to pump and handle while mixing.

Light Weight Additives

Bentonite in Cement. Bentonite has been used as an additive for cements for many years primarily to create lighter weight slurries and reduce water separation. The amount of bentonite will vary from one to twenty-five per cent, depending upon the type of job. Bentonite is a colloidal clay which requires large volumes of water. When used with cement, the additional water is principally responsible in reducing the slurry weights. (Fig. 6).

High percentages of bentonite in cement will cause a reduction of compressive strengths and thickening time of both portland and retarded cements. According to some authors on cement and concrete technology, the high water ratios required for gel cement lowers the resistance to sulfate attack and increases the permeability of the set cement.[11]

Modified Cements. The term "modified cements" here applies to those slurries which are composed of common portland cement (Type I) and high percentages of bentonite (5 to 25 per cent) with 0.5 to 1.5 per cent calcium lignosulfonates.[13] These cementing slurries have properties similar to those of gel cements, except the use of calcium lignosulfonate acts as a retarder and dispersing agent, rendering the cement slurry more pumpable under high temperature well conditions. This type of slurry, when mixed at a high rate of shear, has low fluid loss properties as recommended for permanent type well completion practices.[13]

Pozzolans in Cement. Pozzolans are silicious materials, which in themselves possess no cementitious value but in a finely divided form will, in the presence of water, chemically react with lime at ordinary temperatures to form compounds that have cementitious properties.[14] These pozzolans, when used with portland cement react with the free lime liberated from the cement and thus become cementitious. Pozzlans have been known and used since the time of the ancient Romans and Greeks and structures built by those people are still standing today in testimony to their resistance to various destructive agents.

In recent years, pozzolans have been used in oil well cementing to create a lighter slurry, improve the workability of the cement, obtain better perforating qualities, reduce cementing costs and to increase the resistance of the cement to attack by sulfate or brine waters. Generally speaking, pozzolans are mixed with equal proportions of portland cement for use in oil well cementing. These types of mate-

FIG. 6.
Portland cement containing Bentonite[12]

Per cent Bentonite	Water requirements	Slurry weights	Slurry volume	Compressive strengths 100F	
				24 hours	72 hours
4	7.7	14.1	1.53	1220	2825
8	9.7	13.3	1.82	730	1370
12	13.3	12.6	2.19	395	755

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rials can be accelerated in the same manner as portland cement in reducing the WOC time, or they can be retarded with chemical additives for use in deeper wells.

The early strength of these materials is less than that of normal portland cement, being comparable to gel cements, but will develop strength with time so that the ultimate strength approaches, or may exceed, that of portland cement.[14] These materials are not normally recommended with commercially retarded cements for use in deep wells, as the dilution of the chemical retarder the cement produces an accelerating effect.

Expanded Perlite in Cement. Perlite is a volcanic material which is mined, screened, and expanded by heat to form a cellular product of extremely low weight. It is manufactured for purposes of creating light weight aggregate for cement. Its use with common portland cement or retarded cements, with normally a small percentage of bentonite (2 to 6 per cent) to prevent segregation of the perlite particle from the cement slurry, reduces slurry weights, increases slurry volumes and acts as bridging material for porous or fractured formations encountered while cementing.

In field practice it is always advantageous to mix perlite cement with what might appear to be an excessive amount of water because under pressure these materials act as tiny sponges and take up water from the slurry. This volume change under pressure results in a set cement which has a higher density and lower volume than observed in the cement slurry at atmoshperic conditions.

Hydrocarbons in Cement. Hydrocarbons have been used to a limited extent with portland cement to reduce the slurry weight beyond the normal range of bentonite or perlite cements. The hydrocarbon is first emulsified with water and an emulsifying agent prior to mixing with cement. With such slurries it is possible to obtain weights in the range of eleven pounds per gallon. These types of slurries have a much higher angle of repose than do gel cements and have been used in a few instances on lost circulation jobs where normal weight slurries could not be used.

Hydrocarbons and cement do have disadvantages in that they have low compressive strengths and extra equipment is required to emulsify the fluid prior to mixing. The cost of hydrocarbons, such as kerosene or diesel oil does increase the cementing costs considerably. These slurries have low fluid loss as measured on the Baroid filter press and give high volume yields based on a sack of cement.

Weighting Materials in Cement

Often it is desired to increase the density of the cement slurry for use in deep wells to overcome the high bottom hole pressures. Barium sulfate with a specific gravity of 4.2 has been used effectively to increase the slurry weights to 18 to 19 lb per gallon and is the same type of material used as a weight material for drilling muds.

Other materials having higher specific gravities, such as ferrophosforous, can be used to increase the density of the slurry somewhat more than barium sulfate. Disadvantages are the cost and lack of availability.

Weight materials do not appreciably affect the thickening time of common cement but in some instances cause an acceleration of retarded cements for use in deep wells.

Lost Circulation Additives

Numerous types of lost circulation additives are used in oil well cementing. These include shredded fibrous materials, cellophane flakes, mica flakes, expanded perlites, granulated nut shells, and many others. These agents are used as bridging materials to prevent lost circulation in highly permeable sands or gravels, natural fractures and cavernous formations encountered while cementing.

Some fibrous materials that are commonly used in drilling muds cannot be used in cements because they contain soluble materials which cause a retardation in the setting of the cement. The selection of a proper lost circulation additive will depend on the location of the trouble and the size and type of opening which requires shutting off.

Resins in Cement

Resins can be used effectively in high early and portland cements to improve the cementing bond between the formation and to shut off gas or bottom hole waters where other types of cementing slurries have failed. This type of material is recommended principally for squeeze work and can be used over a wide range of temperature conditions. Resin in cement produces slurries that are handled in the same manner as neat cement and in some instances where small volumes are required, the slurries are placed into the well by use of a dump bailer mechanism. In the mixing of resins with cement it is necessary that the resin and water be pre-mixed prior to the addition of cement. Frequently they are used for "tailing out" a cementing job where trouble has been encountered with bottom hole water.

Under pressure resin cement slurries will compact at the bore of the hole, thus forming a filter cake which reduces the penetration of the fluid from the slurry. The resinous material that has been squeezed into the formation will set and form an effective bond in all types of formations. The disadvantage of this type of cement is the cost of resin which prohibits its use in large volumes. It is, however, one of the most effective materials known for sealing pipe in salt domes for LPG storage or other operations.

Diesel Oil Cement

Diesel oil cement is a material used for squeezing off unwanted formation waters. This type of slurry is a mixture of portland cement, a surface active agent and diesel oil, in which the cement will not hydrate. It is used in the same manner as conventional water slurries but has the advantage that it will not set and harden until in contact with water. This feature given an unlimited pumping time for spotting and relatively small volumes of slurry are required. The surface active agent in diesel oil cement reduces the volume of diesel oil for a given viscosity slurry.

Such slurries are mixed approximately 15 lb per gallon and when squeezed under pressure, produce a high density, high compressive strength material. Water starts to penetrate the slurry as soon as contact is made and continues until the cement has set. The WOC time is governed by the portland cement and the well's temperature conditions.

Gypsum Cements

Special gypsum cements with high early strength and controlled setting times have been designed specifically for oil and gas wells. They are used principally for temporary plugs and develop a high strength in a matter of a few hours. Due to their short time they are usually placed in a well by means of a bailer rather than pumping.

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WEIGHT ON BIT AND ROTARY SPEED

W. M. Booth*

In the rotary drilling process, the two groups of variables which may be controlled are those of a mechanical nature and those of hydraulic type. In the first category are weight on the drilling bit and speed of rotation of the drilling bit (called rotary speed), and in the second category are variables such as mud circulation rate, mud circulation pressure, and mud characteristics.

This discussion deals with the mechanical variables, weight on bit and rotary speed. Mechanical variables are important, first, in that they have a significant effect on penetration rate while drilling, and, second, in that they have a marked effect on the serviceable life of the drilling equipment such as the bit, drill collars, drill pipe, casing, and, to a lesser degree, the kelly, swivel, rotary table, engines, drawworks, and compound.

Weight on Bit

Probably the most important of the mechanical variables is the weight which is carried on the bit when it is drilling. The weight applied is generally supplied by the drill collars immediately above the bit. These drill collars are simply heavy-wall cylinders whose primary function is to provide this weight, and whose secondary function is to serve as a plumb bob for drilling the hole in a straight and vertical manner.

Only a few years ago it was common practice to run only one to three drill collars whose weight might represent only 10 per cent of the total weight carried on the bit. This naturally resulted in severe usage of the drill pipe above the drill collars since the relatively thin-wall drill pipe was designed to be run in tension rather than compression. Today, the trend is toward carrying higher weight on the drilling bit and running longer strings of drill collars of larger diameter; common practice is to employ enough drill collars to supply 10 per cent additional weight over that being carried on the bit after allowing for the buoyancy of the mud.

The effect of weight-on-bit on penetration rate is an interesting and important subject. Field and laboratory tests have shown that the criterion for determining equivalent weight on bit for various sizes of bits is the loading in terms of pounds per inch of bit diameter. For example, in order to make a 12-in. diameter bit drill at the same penetration rate as a 6-in. diameter bit in the same formation, it would be necessary to carry twice as much weight on the 12-in. bit.

In Fig. 1 curves are shown indicating laboratory test data on the effect of weight-on-bit on penetration rate for four types of rocks, grading from soft limestone to pink quartzite, which has a drillability approximately equal to chert. The significant conclusion to be drawn from these curves is that the relationship between weight on bit and penetration rate is not a straight line function. It can be seen that in dolomite, for example, if the weight on bit is doubled from 10,000 lb to 20,000 lb the penetration rate increases from 1.4 to 3.5 ft per hour, a ratio of 2.5. Thus, increases in weight on bit produces large returns in increased penetration rate.

In Fig. 2 there is a presentation of field test data which is interesting in comparison to the laboratory test data shown in Fig. 1. Both the curve for medium-soft shale and for

*Commonwealth Drilling Company, Ltd., Edmonton, Alberta, Canada.

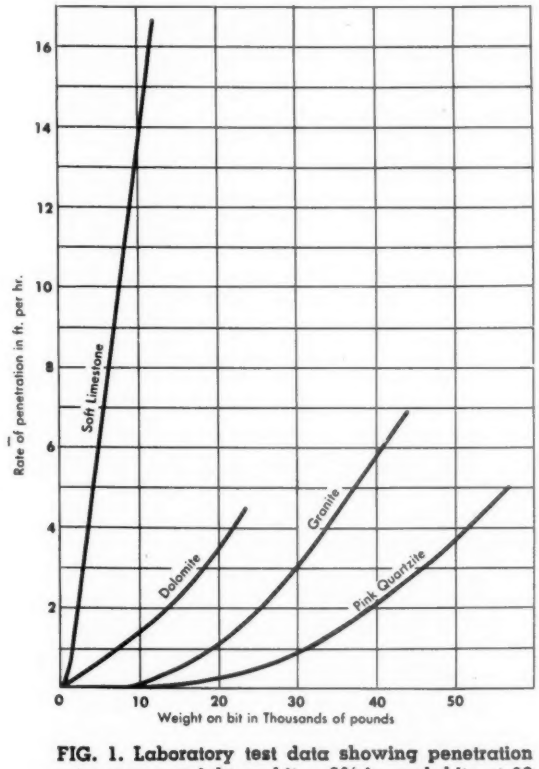


FIG. 1. Laboratory test data showing penetration rate versus weight on bit — 8¾-in. rock bits at 60 rpm. *(Data courtesy Hughes Tool Company)*

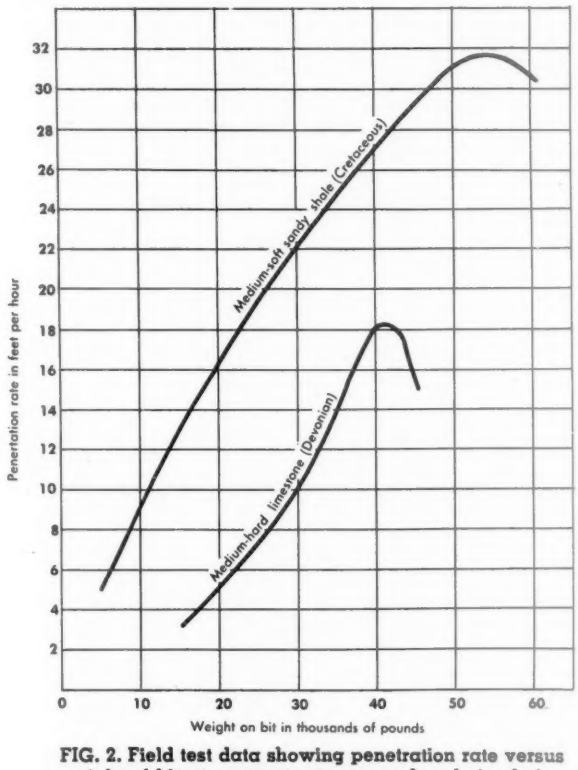
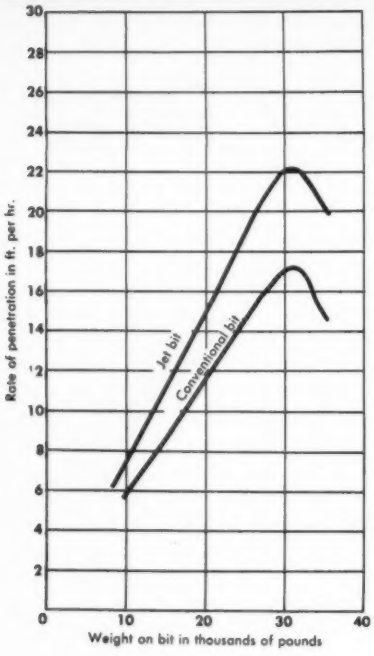
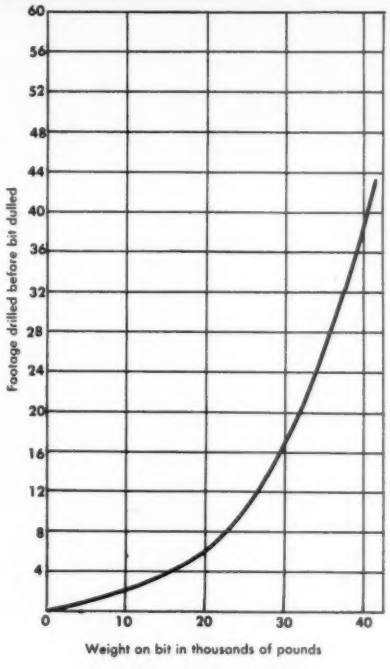


FIG. 2. Field test data showing penetration rate versus weight of bit at constant rotary speed and circulating rate. *(Limestone data courtesy Imperial Oil Limited)*



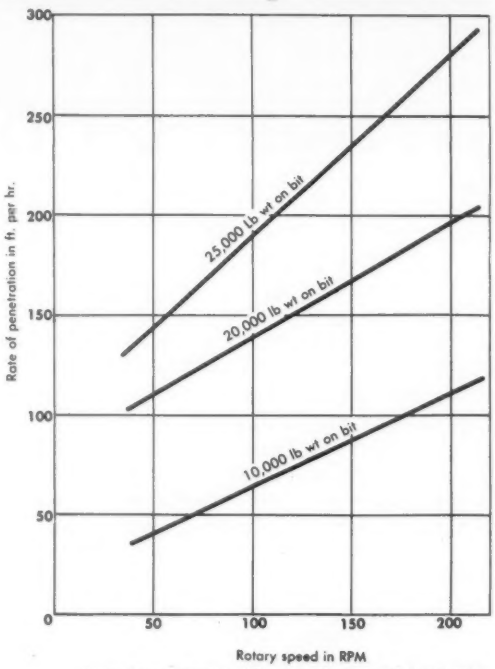
Formation—Viking Sand (cretaceous)
Depth—3500 ft
Bit size—9-in.
Rotary speed—150 rpm
Field—Leduc
(Data courtesy Imperial Oil Ltd.)

FIG. 3. Field test data showing penetration versus weight on bit for jet and conventional bits.



Formation—Oriskany sandstone
Bit size—8¾-in.
Rotary speed—60 rpm
(Data courtesy Hughes Tool Co.)

FIG. 4. Laboratory test data showing footage per bit versus weight on bit.



(Data from "Factors Affecting the Rate of Penetration of Rock Bits," by W. J. Bielstein and Geo. E. Cannon, presented at the Spring Meeting of the Southwestern District, API Division of Production, March, 1950.)

FIG. 5. Field test data showing penetration rate versus rotary speed for jet bits at various weights on bit in soft formation.

medium-hard limestone exhibit an increase in penetration rate with an increase in weight on bit up to a point, beyond which penetration rate is reduced. The reduction in penetration rate as weight on bit is increased beyond this critical point is believed to be a result of the bit being forced into the formation faster than the teeth can produce cuttings and/or the cuttings can be removed by the mud. This point is commonly referred to the balling up point.

Several factors influence this balling up point such as length of the tooth structure on the drilling bit, nature of the formation being drilled, speed of rotation of the drilling bit, mud characteristics, and mud circulation rate and distribution. In certain types of formation this balling up point may not be reached until the weight-carrying capactiy of the bit itself is exceeded. In this case the bearings in the bit or the metal in the shanks or cones of the bit would fail. In any event optimum penetration rate generally can be achieved by running an amount of weight on the bit which approaches either the balling up point or the structural failure point of the bit.

Fig. 3 presents curves of rates of penetration versus weight on bit for a jet bit compared to a conventional bit. These data were secured in an actual drilling test in the field. They show that in this instance both the conventional and the jet bits reached the balling up point at approximately the same weight on bit, although throughout the entire test a higher penetration rate was achieved with the jet bit. This experience has not been the case in some areas and various writers have reported that the use of jet bits has permitted higher weight to be carried on the bit before the balling up point is reached.

The effect of weight on bit on the footage of hole a bit can drill before becoming dull is shown in Fig. 4. This curve is based on laboratory test data with a standard size rock bit drilling on a hard sandstone. It can be seen that in this test, the footage before the bit was dulled was increased greatly by increasing the weight carried on bit. This is generally in line with field experience.

Weight on bit is not always dictated in actual practice by a desire to achieve optimum penetration rate. If there is a tendency for the hole to deviate from the vertical, for example, reduced weight on bit is the most common practice employed to offset this tendency. As another example, there are times when lost circulation is encountered and weight on bit is reduced to retard penetration rate so that materials which have been added to the mud to overcome lost circulation will have time to do their job as new hole is opened up. In general the range of weight on bit commonly used is from 3000 to 6000 lbs per inch of bit diameter, but in extreme cases up to 10,000 lbs per inch of diameter has been run.

Rotary Speed

Rotary speed is a mechanical drilling variable closely tied into weight on bit and depth of hole. If very high weight on bit is employed it is common practice to reduce rotary speed accordingly to stay within the limits of structural strength of the drilling bit; conversely, if very light weight on bit is being employed, high rotary speed is normally used.

The depth at which drilling operations are being conducted influences rotary speed in that the chances of drill pipe or drill collar failure and the resulting expense of a fishing job are increased as the hole goes deeper. Consequently rotary table speed is generally reduced as depth increases. This is appropriate in another respect since the formations generally become harder to drill as depth increases and weight on bit must be increased; rotary speed would have to be reduced for the sake of the bit itself.

Fig. 5 shows the results of field tests to determine the effect of rotary speed on rate of penetration in very soft formation. The three curves display a straight line characteristic for three different weights on bit, and the trend is toward the limit of the test which was around 200 rpm.

This type of curve holds true for most formations but quite often it has been found that wear on the teeth of the drilling bit increases rapidly as rotary speed is increased and it is more economical to run at lower rotary speeds. Drilling practice today employs rotary speeds from 30 rpm for extremely heavy weight on bit and for certain special bits, up to 300 to 500 rpm for lighter weight on bit and soft formations.

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Strongly constructed, the tool may be used in connection with any rotary jar and will withstand any pull that may be placed on 4½-inch drill pipe. A time-saving feature of this new tool is that, when the fish is recovered, instead of having to do the usual difficult stripping job, the spear may be released and lowered to the control bushing and the wash pipe laid down before handling the fish.

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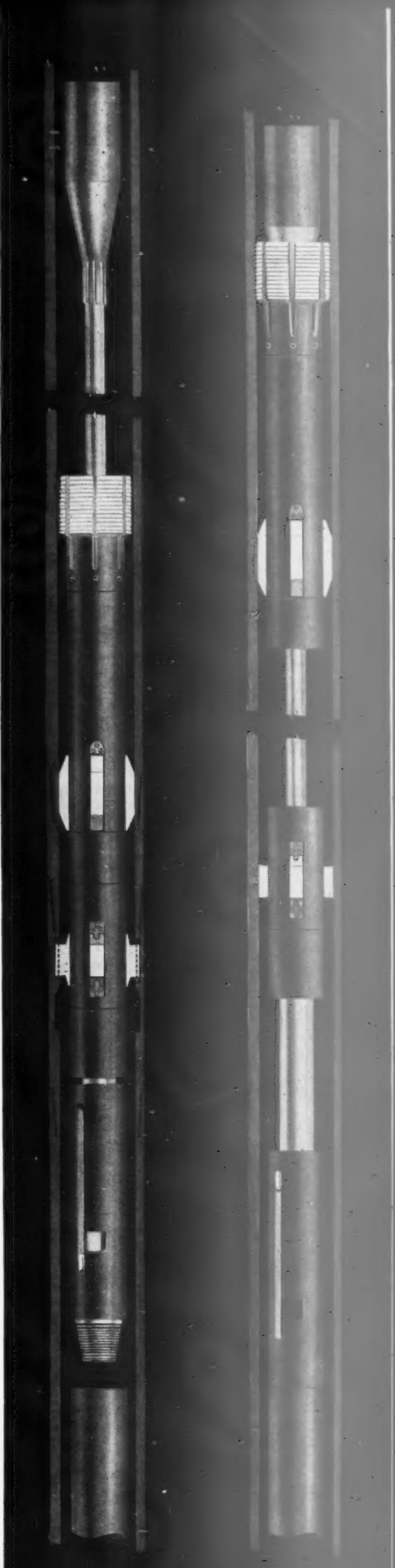

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Well Logging From Drill Returns

This tool is aiding the search for oil by picking up otherwise unnoticed shows and by reducing exploration costs

E. F. PETERS

MUD logging units or trucks are now used extensively by practically all oil companies in California on a large part of their exploratory wells. The principal purpose of this service is the continuous analysis of the drill returns for the presence of oil and gas that might denote producing intervals. A number of terms have been applied for this type of service, such as mud logging, formation logging, cuttings analysis, hydrocarbon logging, drilling fluids analysis, and geological well logging.

The variety of terms indicates the scope of service and also different approaches for the determination of the diagnostic factors. Generally speaking, formation logging may be described as an instrumental refinement of the geologist's art in watching the ditch of a drilling well for oil and gas shows.

Good Drill Mud Will Mask Oil Shows

In modern rotary drilling with good mud control, such shows, as a rule, are not readily discernible by the naked eye or even under the microscope. It required the introduction of various instruments, principally of the hot wire gas analyzer and of crude oil activating fluorescent light sources, plus a rigid systematizing of procedure and the recognition of new diagnostic factors, to make a valuable tool out of this oldest and natural method of finding oil while drilling.

Good Logging Will Bring Them Out

The major advantages of continuous formation logging are apparent:

Supplementation of the Electric Log. Numerous geological areas exist in California where oil or gas producing horizons do not show on an electirc log. Sometimes even the lithology is not defined by these electrical values. Frequently, electric log patterns and computed electrical values supposedly characteristic for production appear opposite a barren or wet zone, causing uneasiness and considerable testing expenses.

It is in these cases, or where their existence may be suspected, that formation logging with its direct visual evidence and direct hydrocarbon analysis is of the greatest value and finds its fullest justification. Its application may lead to the discovery of new producing horizons and new oil pools, which, not having been known to produce previously, are apt to be neglected in coring and testing programs.

A number of such instances, involving substantial oil pools, have occurred in California, where credit for discovery was given to formation logging methods as a measure of the scope of the role of formation logging in the California exploration drilling picture, it may be said that in California, since January, 1953, some 35 new oil pools and discoveries of all types have been successfully indicated by formation logging. Instances where formation logging failed to furnish clues for the existence of producing oil intervals are not known.

Economic Drilling of Exploratory Wells. Exploratory economies are effected mainly in areas with multiple objectives and bad faulting. They consist of savings on such items as coring costs and excessive testing expenses. Further advantages and applications of formation logging include

Determination of probable producing intervals in fractured shale sections.

Positive indication of gas sands.

Continuous gas check for blow-out protection.

Provision of a continuous drill rate curve.

Well site core analyses.

Well Logging History

A few remarks about the history of the development of the instrumental aids for logging oil and gas may be of interest. The commercial version of this type of well bore surveys was originally introduced as a "mud logging service" in the early '40's in California. The procedure used at that time involved an analysis and inspection of the drilling mud and was based on the theories of J. T. Hayward.

Preceding Hayward's systematization and coordination of various instruments and methods into a logging system, such methods and tools had been utilized at various places in the oil industry for the discovery of oil and gas sands while drilling.

The Author

E. F. Peters is the head of Formation Logging Service Company, Los Angeles, California, which company he founded in 1944. This article is based on experience gained in logging several million feet of hole, mostly in California. His company has operated also in the Rocky Mountains and in South America. Peters was graduated from Institute of Technology, Berlin, where he received his E. M. degree in 1925. Since then he has been active in various phases of the oil industry, including field engineering, exploration and geological work.

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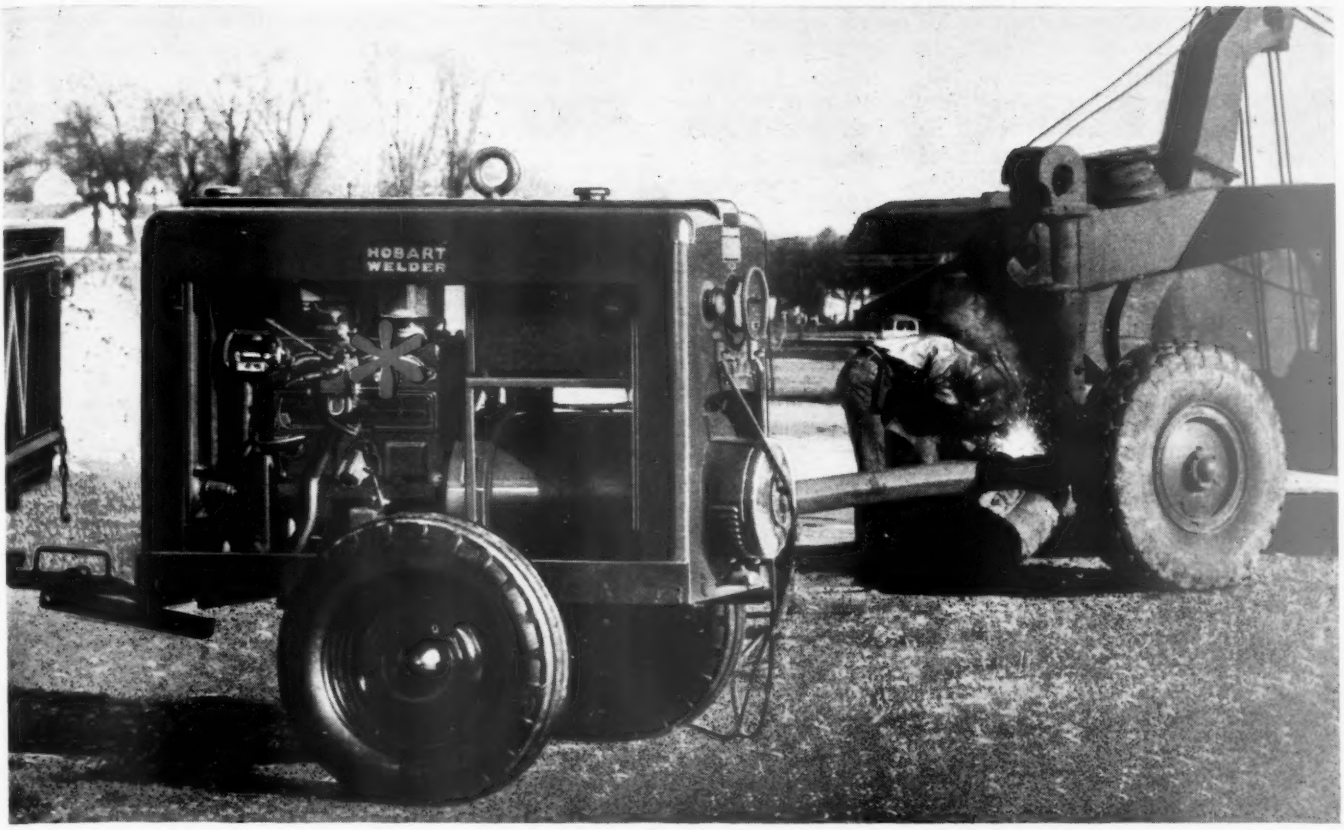

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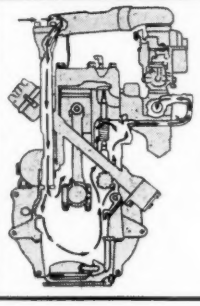

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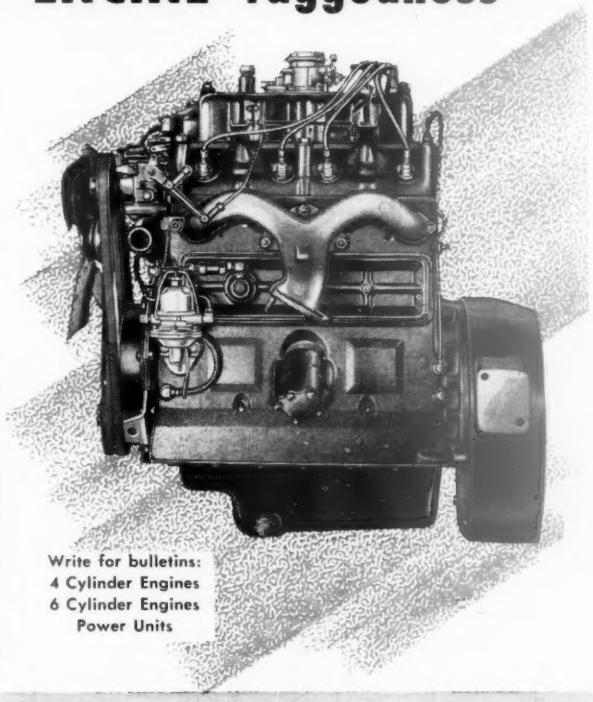

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The earliest reported instance of the application of instruments to the analysis of drill returns occurred in California. Tribute is due Z. H. Bissel, who, in 1927 and 1928, first analyzed the fumes of gas in the drill returns of drilling wells for the purpose of locating gas sands while drilling.

Bissel, now retired, was then an engineer of the Southern California Gas Company. He devised a gas trap at the end of the flow line, through which the drilling mud had to pass. The gas liberated in this trap was then analyzed for the presence of methane and higher hydrocarbon fractions so that gas sands could be located. Gas was of little value then, however, and the inquiry for gas sands on wildcat wells was not continued.

Just as the first "gas logging" was apparently done in California, so the first printed mention of the use of the ultra-violet light for the logging of crude oil in muddy drill cuttings by means of the ultra-violet light likewise occurred in California.

John Melhase describes its use in an article of the magazine, *The Mineralogist*, in February, 1936, entitled "Fluorescence As An Aid in Correlating Oil Sands." Discovery, identification, and correlation of oil sands by color of their fluorescence are explained in this article.

When mud logging was first introduced in California in 1941 or 1942, the results were partially promising but also partially disappointing. The disappointments were due to three main reasons.

1. The erroneous theory that the formation fluids from the pore spaces of the drilled-up bore hole section were of necessity conveyed into the mud stream and could then be found in the mud and that thereby oil sands could be reliably located while drilling.

As a matter of fact, probably as many as one-third of the cases of new oil sands discovered in California by mud logging were made in horizons where no significant traces of oil were found in the mud; consequently, it became evident that mere mud logging was not a reliable tool for the location of oil sands.

2. The erroneous proposition that, as the formation gas had likewise supposedly originated in the pore spaces of the drilled-up section, the magnitude of gas shows was a measure or index of the producibility of a sand.

This theory did not consider geological realities. It developed that in gas country the geological section tended to be interspersed with minute accumulations of gas that were under very high pressure. These pockets consequently discharged almost instantaneously relatively large quantities of gas into the mud stream as soon as they were tapped by the drill. Consequently, a high percentage of large gas kicks from the mud have no significance, as far as producibility and volume of gas are concerned.

3. The treatment of the mud logging technique as a strictly mechanical recording of numerical values, without at the same time observing and evaluating and coordinating the frequently paramount influence of geological factors that cannot be reduced to quantitative terms.

Geological Factors of Prime Importance

From about 1944 on, the concept gained ground that geological factors could not be neglected in mud logging. This mean, first of all, that the evidence of oil and gas contained in the drill cuttings was of primary importance. It had always been so, of course, for the well-sitting geologists.

New logging companies entered the well logging field in Texas and California. Their "mud logs" reflected the visible residual amount of oil on the drill cuttings rather than in the mud. The oil curve was drafted by evaluating a carbon tet cut, either by the degree of opaqueness under the U-V light or by looking at a residual oil ring after the carbon tet had evaporated.

Another oil logging method was the recognizing and judging of live formation oil in cuttings samples. The carbon tet factor is highly sensitive and shows without differentiation cuts from residual tar, from mere stains, and from prolific producing sands. The logs of some logging companies show both of the described oil factors, others show "oil in mud," and carbon tet cut.

Lithology Report Included

Another feature was added to the mud logs at this time by the inclusion of an accurate lithology log. This was of great help to geology departments in further evaluating the worth of reported oil and gas shows.

Some logging companies adopted the policy of employing geologists for the logging work, realizing that the necessary observation of numerous geological factors made a geological background desirable.

One other new factor in mud logging work that was introduced at about this time deserves special mention—that is, the measurement of gas, or rather hydrocarbon volatiles, in cuttings samples. This parameter was first utilized for the delineation of probable producing horizons by Jack Bliss in West Texas. It proved to be a very valuable factor for the determination of oil horizons and has been adopted by most logging companies.

Improvements Increased Tool Use

The aforementioned improvements in techniques and the changes in approach gave the mud logging industry in California a new impetus. Oil companies found that a more helpful tool in exploratory drilling had been developed. Around 1944, less than a handfull of oil companies in California were interested in mud logging, as many companies had dropped the matter. By contrast, in the past 10 years at least 50 oil companies have come to use the service.

Progress was slow and arduous until about 1949. Good results had been demonstrated by then, which changed the thinking of the oil companies, and the application of the service spread to most important wildcats drilled in the state.

Simultaneously, as many as a dozen different logging companies or individuals entered the mud logging field, at least intermittently. At an average there are probably 12 to 15 units active in the state with permanent logging crews. Some of these companies provide all-geological logging teams for this service.

Better Procedure Aids Technique

The great improvements in mud logging during the past ten years have been along the lines of procedure and method and coordination of information, rather than in instrumentation. There was never any question that the sensitivity of the principal instruments —that is, the gas analyzer and the more efficient types of the U-V equipment —were adequate to detect hydrocarbon in drill returns.

Similar to the background level in radiation measurements, there is a contamination level of various degrees present in most wells. There is no reason to increase the sensitivity of the instruments after the operating range covers the contamination level. Other criteria must then apply, as has already been pointed out. Refinements of instrumentation were mainly made, therefore, in the direction of convenience of operation, consistency of the pick-ups, and reliability of working parts, as well as in automatic recording of some factors and in better sampling techniques.

The original method of pumping mud into the logging trailers, which led to operational failures, has been rather generally replaced by a gas pickup at the flow line or at the ditch.

Various types of U-V equipment were better suited to the fluctuating power supply of the average drilling rig. The better designs of the U-V lamp will pick up the poorly fluorescent types of crude oil, low gravity oil, and condensates.

Sampling techniques have also been improved by some logging companies. Various types of drill rate indicators have been developed. Some of them plot the progress of the drill entirely automatically, while others depend on the cooperation of the driller.

The progress of the drill is transmitted to the logging trailer either mechanically or hydraulically. Either method has its advantages. The important part is that a graphic and automatically continuous record is available which pin-points formation changes and tops of producing intervals and delineates very small sandstringers.

Such an accurate curve frequently has good value for correlation, besides providing a permanent picture of the drilling operation.

The apparatus for cuttings analysis, which is called a micro-analysis by some loggers, consists of an agitator or a blendor which disintegrates a ditch sample and disperses the hydrocarbon volatiles, if present, in a test cup. The resulting gas-air mixture is then analyzed in a conventional gas analyzer.

While the basic procedure is identical with all loggers, there are differences in sample sizes, in calibration of the gas analyzer, in the mode of withdrawal of the mixture and in sample techniques, so the results are not directly comparable from log to log with different logging companies.

Application

The field of application of formation logging is primarily that of exploration drilling. In areas with well defined, single geological objectives, where good correlation is available, formation logging is not advisable. Most of California geology is complex, however, not only structurally but also depositionally. This is why formation logging has proved its merit in virtually all producing and wildcat areas of the state.

Generally speaking, most California oil companies use formation logging where the following conditions are encountered:

- Lack of resolving power of the electrical measurements of the electric log (silty sands, bentonitic sands, series of thin producing stringers, production from continental beds),
- Multiple objectives,
- Badly faulted structures,
- Stratigraphic plays,
- Very deep objectives,
- Fractured shale exploration, and
- To a more limited extent: gas plays.

Several of these conditions could prevail in any one area.

Formation logging has therefore been used extensively and successfully in the Los Angeles Basin in the search for deeper production in known fields, in the exploration for new fault blocks on the flanks of known structures and in sections where the electric logs show no significant anomalies in producing intervals.

Ventura Area Proper Application for Tool

Another outstanding successful area for formation logging has been the Ventura Basin, especially the vicinity of Newhall. Here many producing intervals, complicated geology, rapid facies changes, and great depth combine to make the geological section, and hence exploration drilling, rather unpredictable.

Another problem in this area is the evaluation of the producing properties of the continental Sespe formation, with its usually numerous noncommercial oil shows and indefinite E-logs. Good formation logging procedures proved very helpful there.

The Santa Maria Basin and the Lost Hills Areas near Bakersfield are examples of fractured shale type reservoirs, where formation logging has helped in delineating producing intervals.

Other areas that have seen advantageous use of mud logging are the west side and the southern end of the San Joaquin Valley, the Cuyama Valley, the Salinas Valley, the Sacramento Valley gas areas and practically all wildcat areas from the Salton Sea in the far south to the northern areas, like the Livermore Basin and Humboldt County.

Economics of Formation Logging

As previously stated, formation logging can, and in most cases, does result in more economical exploratory drilling. This holds true, if the service is integrated with the rest of the evaluating steps and the whole drilling program.

Frequently, such savings are very obvious. Sometimes, however, they are difficult to evaluate by strict accounting procedures.

Formation logging is really something more than just an additional tool in exploratory drilling. It is a way of drilling such wells, which not only affects the cost picture of all other evaluating steps, but also the straight drilling costs.

While cost of development wells can be exactly compared from well to well, such is not possible for wildcat wells, as every well is different and has different problems. Many companies, however, have made general analyses based on reasonable hypotheses which show that, where the conditions analyzed above are encountered, quite substantial savings in overall drilling costs can be demonstrated. Extensive data indicates that such savings can amount to 10 to 20 per cent of the drilling costs.

Such savings and advantages include reduction of coring programs to points of interest and to instances when the logger picks up first shows, elimination of expensive tests in cases that are clear-cut from the formation log, occasional sparing of a casing string, avoidance of some re-drills, availability of operators, and geological personnel for other assignments, and a number of minor conveniences available from logging trucks.

Gas Logging

A word should be said about the experience with mud logging in the gas territories of California. Here a distinction must be made between dry gas and wet gas deposits.

The delineation of wet gas or condensate producing intervals presents problems that are, on the whole, not very much different from those in logging oil horizons. The available logging factors have generally proved quite satisfactory and diagnostic on such prospects.

A type of fluorescence, characteristic of condensates, can be brought out in the drill samples, stain will usually be in evidence on the cuttings and residual volatiles can be detected from drill returns and cuttings. One minor problem is the selection of suitable U-V equipment.

The situation changes, however, when the logging problem concerns the discovery of commercial dry gas horizons. Of the number of positive and reliable factors available for oil logging, only two, the ditch gas and the lithology, remain in gas logging as guides.

The magnitude of a ditch gas show, and therefore the unit reading on the gas analyzer, depends primarily on the pressure differential between hole pressure (mud column) and bottom hole pressure of the formation.

Gas volume in place — the factor which we really desire to evaluate numerically—plays only a secondary role in influencing the ditch gas readings.

Since most gaseous sections contain an abundance of smaller accumulations of gas under high pressure, which are aptly called "high pressure low-volume pockets," it has been a quite common experience that many high gas kicks are recorded on such a prospect that are of no commercial significance.

Helpful observation under such circumstances are the minute inspection of the lithology and of the pattern of build-up of the gas show. There is valid information in a mud log, when no shows whatsoever are encountered.

XUM

Fortunately, electrical logs are quite diagnostic in most gas areas, so that from a combination of the two logs a helpful guide for further testing can be derived. Many unsuccessful tests have been made, however, and more must be anticipated, in gas exploration.

The evaluation of dry gas horizons is a difficult exploration problem and frequently every bit of information is helpful. Whether the expense of mud logging is justified for the drilling of dry gas prospects, depends primarily on individual circumstances.

Rating of Oil and Gas in Units

All oil and gas units in logging from drill returns are either empirical values or are based on arbitrary reference levels. As a large number of different loggers have recently entered the well logging business, a special problem has been created for the engineers of oil companies, concerning the meaning and relative relationship of the gas units and oil units systems employed by the different people.

It must be understood that these logs and the magnitude of shows are not absolutely and unconditionally reproducible values; as far as the oil values are concerned, they are not even measured values, nor are they derived by the same methods.

Furthermore, there are too many variable factors in the subsurface which keep geology from being an exact science. In the hands of an experienced geologist, however, geology is an art that has created the great oil industry.

Since formation logging deals mostly with geological phenomena, it is by nature also inexact, and the resolving power and reliability and the numerical values of a formation log are, in a large number of situations, a function of the experience and the geological knowledge of the logging personnel.

Naturally, in the case of prolific sand bodies, the choice of logging procedures and instrumentation is rather immaterial. Such sands are easily detected and would probably show uniformly on all mud logs. At the present time, however, exploration in California is frequently concerned with the search for marginal sands, for small pinch-outs and for very deep prospects. Variations in testing procedures and sampling techniques, based on a recognition of a geological situation, would in such cases produce considerable differences in the logs presented by the different loggers.

It is obvious therefore that a "comparison scale" from logger to logger would be meaningless. To draw any comparison at all, it would first be necessary to know the respective procedural steps, sample techniques, personnel factors, etc.

Many petroleum engineers, who, as engineers, are used to dealing in definite quantities with a definite deducible significance to a given quantity, find the fact disconcerting that in mud logging a geological condition like lithology or the properties of the drilling mud can change the significance of a measured factor by more than an order of magnitude.

The critical factor in California formation logging is, therefore, frequently lithology. This means not just its recognition and description, but an educated evaluation of its effects on the numerical values. This also means versatility and adaptation of logging procedure to a variety of specific conditions.

While a superficial and rough standardization of several logging factors would be possible and desirable, and would constitute some improvement over the present state of wide and variable disparity in unit rating systems, it is clear that the fine points of procedure cannot be standardized. However, these points are critical more often than not, under California geological and drilling conditions.

Drilling Mud Properties Important

A final set of conditions that affects the oil and gas unit readings and ratings as well as logging procedures, the properties of the drilling mud, must be mentioned here.

The influence of high mud weight and viscosity on ditch gas shows is well known and can be taken into account. The effect of oil-emulsion muds however introduces factors that make formation logging somewhat more difficult.

The masking effect of any remaining fluorescence of the emulsion oil may be troublesome, if its color is close to that of the crude oil to be detected, and the abundance of oil in a sample complicates the picture.

More detrimental, however, are the detergent and solvent actions of the mud of the formation oil in the drill cuttings rising in the hole.

It is conceivable that in a deep test, some oil evidence may become difficult to detect even by today's refined logging techniques. * * *

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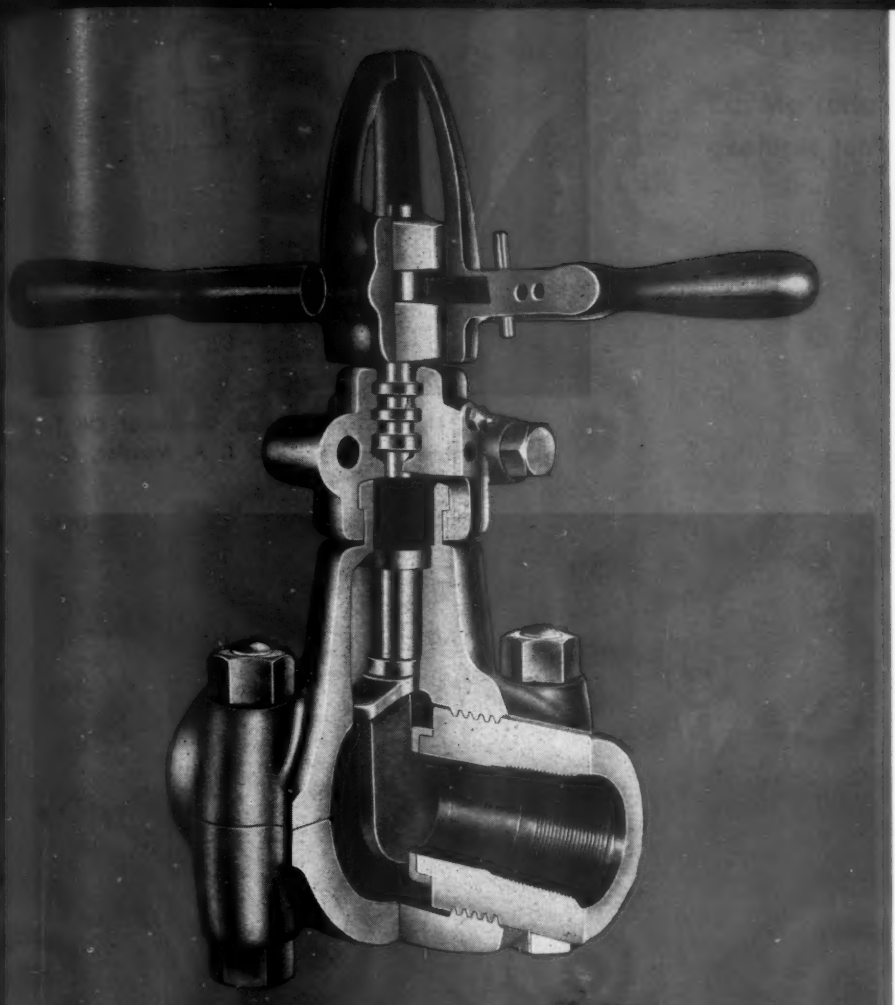

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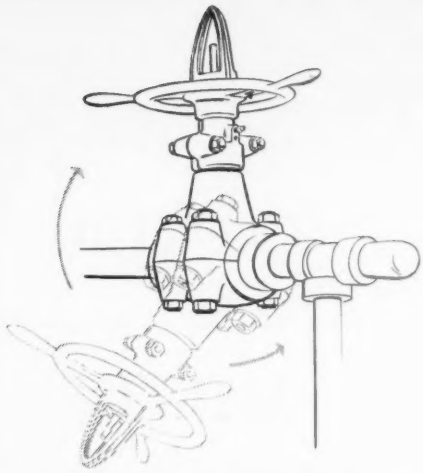

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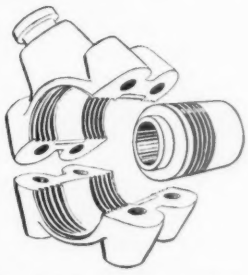

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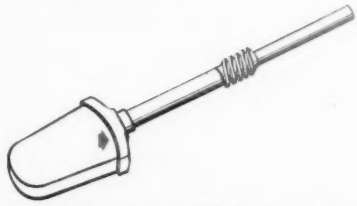
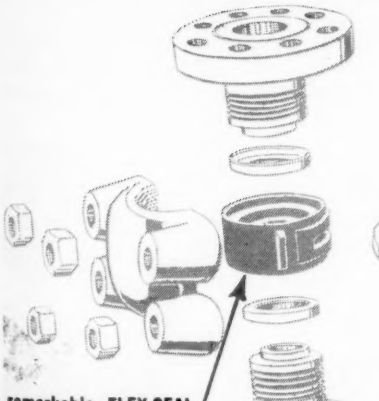


This shoulder on the Flex-Seal gate contacts the top of the gate packer when in the closed position, thus preventing "flowing" of the resilient packer and prolonging its life.



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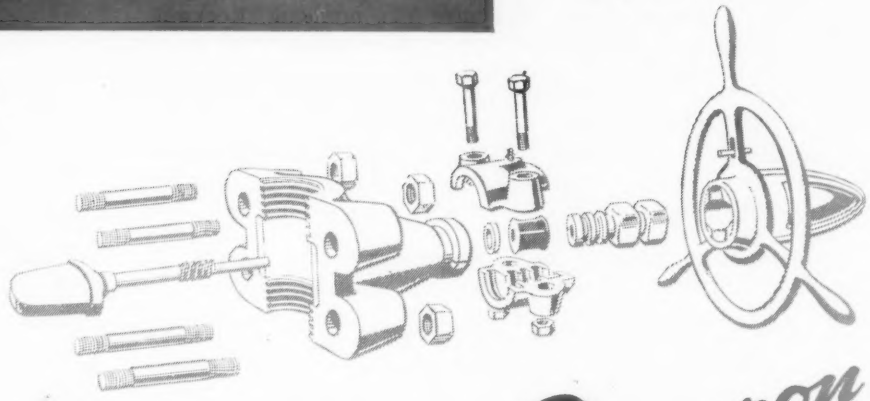

FLEX-SEAL Valves have a lot of parts and there's a good reason for it. Each individual part is replaceable at a minimum of expense. The replacement of small, inexpensive parts and the elimination of costly delays, transportation, and valve repair shop charges, has found favor with cost-conscious operators the world over.

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Continental has ANNUAL MEETING

H. H. Peters, president, Technical Oil Tool Corporation, left, and J. A. Mussler, Continental sales manager

F. M. Mayer, president of The Continental Supply Company, is shown at left greeting a party from The Youngstown Sheet & Tube Company. Second from left is A. S. Glossbrenner, Youngstown vice president; next, M. H. Watkins, vice president; and J. L. Mauthe, president; Mrs. Mauthe

THE Continental Supply Company's fifteenth annual sales meeting was held in Dallas, Texas, March 6, 7, and 8, with 260 Continental men attending from the United States and from the company's foreign points.

Various phases of merchandising were discussed with special meetings held for specialists in drilling equipment, production equipment, and tubular goods. In addition, representatives of Continental's associated manufacturers participated in some sessions.

J. L. Mauthe, president of The Youngstown Sheet & Tube Company, Continental's parent organization, was among the distinguished guests present, along with M. H. Watkins and A. S. Glossbrenner, vice presidents. Among other associated companies' officials present were J. H. Bascom, executive vice president, Broderick & Bascom Rope Company; E. M. Rhodes, manager, roller chain division, Chain Belt Company; George B. Flanigan, manager trade relations, Chain Belt Company; T. Bruce Cox, manager union sales, Clayton Mark & Company; W. T. Powell, president, Emsco Manufacturing Company; W. C. Kinder, vice president and general manager of sales, Emsco; G. V. Leece, president, Gardner-Denver Company, and A. H. Jones and A. G. Lindquist, vice presidents, Gardner-Denver.

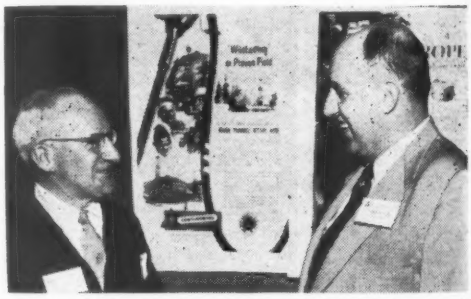
Also J. F. Hacker, vice president, Ladish Company; Paul M. Arnall, president, The Lunkenheimer Company; Martin Walter, Jr., president, New Bedford Cordage Company; Robert A. Snyder, vice president, New Bedford Cordage Company; J. A. Conlon, vice president, New York Belting & Packing Company; L. A. Dixon, Sr., executive vice president, Rockwell Manufacturing Company, Nordstrom division; C. K. Madison, vice president, Rockwell Manufacturing Company, Nordstrom division; H. H. Peters, president, Technical Oil Tool Corporation; and E. G. McConnell, vice president, Technical Oil Tool Corporation.

Registration began Sunday morning and except for a few business meetings, most of the day was devoted to visiting, a gin rummy tournament, showing of films, and tours through the company's offices. The group attended a banquet Monday night.

R. A. Brewer, division manager, Tulsa, was winner of the gin rummy tournament. L. D. Murphy of city sales in Houston, was runner-up.

The annual 25-Year Club Dinner was one of the highlights of Sunday night's festivities. C. H. Fischer, district manager, Evansville, Indiana, was elected president for 1955. Howard D. Nesbit, Dallas city sales, was elected vice president; and T. M. Heraty, drilling equipment division, Dallas, secretary.

F. M. Mayer, president, and F. I. Brinegar, executive vice president, welcomed the group at the opening of the business session Monday morning. J. A. Mussler, general manager of sales, was moderator for the meeting.



▲ J. A. Conlon, vice president, New York Belting & Packing, and F. I. Brinegar, executive vice president, Continental

▼ George B. Flanigan, manager trade relations, Chain Belt, left, and J. Allen Whitesides, manager drilling equipment, Continental

XUM

Ca/Mg ratio of ground water indicated as useful geologic tool for finding petroleum deposits

Water Study as Exploration Aid

George V. Chilingar

THE Ca/Mg ratio of carbonate rocks is a very useful geologic tool for identifying carbonate rocks, for correlation purposes, as a geologic thermometer, and in porosity studies, as pointed out by Chilingar (1953).[1] A review of Soviet geological literature showed that Ca/Mg ratio is also a useful tool in prospecting for petroleum and natural gas deposit (Kaveev, 1948).[2]

The geochemical methods of exploration have been widely used in USSR during the last ten years, and include gaseous, bacteriological, luminescent, and oxidation-reduction potential methods. All these methods are based either on the presence of hydrocarbons in the upper layers of sediments or their effect on the surrounding environment.

Kaveev* (1948) studied the spring fresh-waters of Tat. A. S. S. R. in order to establish the relationship between their chemical composition and proximity to the oil-bearing formations. His study was based on the principle that the presence of hydrocarbons will result in chemical changes of the associated ground waters.

Table 1 shows the average composition of spring waters of Tat. A. S. S. R., whereas Table 2 presents the chemical composition of spring waters in the oil-bearing areas of the same republic. The results shown in Table 2 differ from those of Table 1, with considerable difference in the relative amounts of alkali earth metals.

For more precise comparison, Kaveev examined spring waters which are in direct contact with bituminous Sarabikulovskii formation (Table 3, Analysis No. 1) and waters of the same horizon at some distance from bituminous rocks (Table 3, Analysis No. 2).

The spring waters of oil-bearing areas show decreases in the Ca/Mg raios, increase in the amounts of CO_2 and CH_4, and appearance of sulfides. The presence of sulfides in equilibrium with alkaline earth metals results in higher pH, whereas presence of H_2S lowers the pH.

*Study of Underground Waters of Tartar Autonomous Socialist Soviet Republic (Tat. A. S. S. R.) by M. S. Kaveev.

TABLE 1. Average composition of Tat. A.S.S.R. spring waters.*

Geologic age	Average number of analyses	pH	Average hard residue mg/liter	Average ionic composition mg/liter					Ca/Mg ratio
				HCO_3^-	$SO_4^=$	Cl^-	Ca^{++}	Mg^{++}	
Q	17	—	280.61	5.08	0.58	0.30	3.86	1.69	2.28
P_2^{tat}	36	7.2	357.44	6.70	0.33	0.14	4.02	2.20	1.83
$P_2^{KaZ_2}$	86	7.3	510.68	5.28	2.73	0.34	6.88	2.48	2.78
$P_2^{KaZ_1}$	42	7.2	336.96	5.39	1.34	0.17	4.31	2.10	2.05
P_{1+2}^{uf}	23	7.2	815.51	5.57	6.97	2.07	7.05	3.56	1.98
	204 Total	7.2 Average	460.1 Average	5.60 Average	2.39 Average	0.60 Average	5.22 Average	2.40 Average	

* Gaseous content of Tat. A. S. S. R. spring waters is characterized by dissolved air.

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TABLE 2. Chemical analysis of spring waters in petroliferous areas of Tat A.S.S.R.

Location	Geologic Age	pH	Hard residue mg/liter	H_2S+HS mg/liter	Ionic composition in mg—equivalents HCO_3^-	$SO_4^=$	Cl^-	Ca^{++}	Mg^{++}	Ca/Mg ratio
Shchugurovo, spring 104	$P_2^{KaZ_1}$	7.8	812.0	Not detected	6.13	7.98	0.08	0.19	0.46	0.416
Cheremshan, spring	$P_2^{KaZ_2}$	7.8	2318.	Not detected	3.16	280.16	0.17	22.99	63.91	0.37
Nurlatak, region, igolkino	P_2^{tat}	—	1004.	Not detected	9.19	4.62	1.87	3.52	6.54	0.555
Krym—sarai	$P_2^{KaZ_2}$	—	—	—	3.38	1.61	0.08	1.84	2.12	0.868
Irekly (R. Milli)	$P_2^{KaZ_1}$	6.3	—	—	5.48	0.20	0.17	2.33	2.52	0.925
Urazaevo (R. Elga)	$P_2^{KaZ_1}$	7.6	—	—	8.93	0.82	0.14	2.86	6.09	0.469
Asnakaevo	$P_2^{KaZ_2}$	7.5	—	17.99	6.10	0.37	0.10	2.72	2.87	0.948
Shadchi (R. B. Shiia)	—	6.9	318.0	—	5.70	0.21	0.15	1.75	3.65	0.478

The comparison of chemical analyses of spring waters in the Shchugurovskii region, with the results of bacteriological and gasesous surveys shows a definite correlation between the spring waters with $Ca/Mg < 1$ and formations with abundant anaerobic bacteria and high hydrocarbon content. Kaveev also found that with lower rH values (oxidation-reduction potential), which indicate reducing environments, Ca/Mg ratio of spring water is less than one. All this indicates the validity of Kaveev's method.

The study of the gaseous and chemical compositions of the spring waters, namely amounts of Ca^{++}, Mg^{++}, $CO_3^=$ (HCO_3^-), SO_3, H_2S + HS, Cl, CO_2, and CH_4, during the geological mapping of an area can be of great value in locating petroleum and natural gas deposits. The main value of this method lies in its simplicity.

The spring waters of the petroliferous areas of Tat. A. S. S. R. are characterized by lower Ca/Mg ratios, increasing amounts of CO_2 and CH_4, and presence of sulfides.

Acknowledgments

The review of manuscript by Dr. J. Currey, assistant-chief of Petroleum and Chemicals Laboratory, Wright-Patterson Air Force Base, is greatly appreciated.

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2. Kaveev, M. S. (1948) Toward Problems of Exploration of Petroleum by Hydrochemical Methods: *Doklady Akademii Nauk SSSR*, Vol. LXI, No. 2, pp 329-331.

TABLE 3. Comparison between chemical composition of ground waters from the same horizon (Sarabikulovskii formation).*

Number	Geologic age	pH	Hard residue mg/liter	H_2S+HS mg/liter	Ionic composition mg/liter HCO_3^-	$SO_4^=$	Cl^-	Ca^{++}	Mg^{++}	Gaseous composition in per cent CO_2	O_2	CH_4	N_2	Ca/Mg ratio
1	P_1	>7.0	2332.40	233.24	15.16	0.11	3.46	2.73	10.30	60.00	0.50	10.40	22.30	0.27
2	P_1	>7.0	4205.00	6.80	2.38	52.64	1.23	17.68	15.12	16.20	2.50	0.50	78.00	1.17

* Analysis No. 1—Spring waters in contact with bituminous rocks.
Analysis No. 2—Spring waters not in contact with bituminous rocks.

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Single element construction, tungsten carbide valve, nylon valve seat and a minimum of working parts — assures trouble-free performance and long life operation.

So . . . get the real pitch on what Merla's new Type "C" gas lift valve can do for you by contacting your nearest Merla field office listed below.

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Engineering Service Co., Corpus Christi, Ph. 3-4489 — Odex Eng. & Eqpt. Co., Odessa, Ph. 7-3568 — Cliff Mock Co., Houston, Ph. Olive 2041, Lake Charles, Ph. 6-8264; New Iberia, Ph. 2-3626; Lafayette, Ph. 4-1824 — Hudson-Eads, Inc., Wichita Falls, Ph. 2-8584; Abilene, Ph. 2-5331 — Merla Tool Corp., Shreveport, Ph 5-3701; Oklahoma City, Ph. Melrose 2-6983 — A. R. Greer, Farmington, Ph. Davis 5-3123 — Swan Specialties Co., Casper, Ph. 2-2689 — Eastman Oil Well Survey Co., Calgary, Ph. 3-3446 — Petroleum Ind. Consultants, Caracas, Venezuela, Ph. 57.092.

EXPLORATION ACTIVITIES

TEXAS

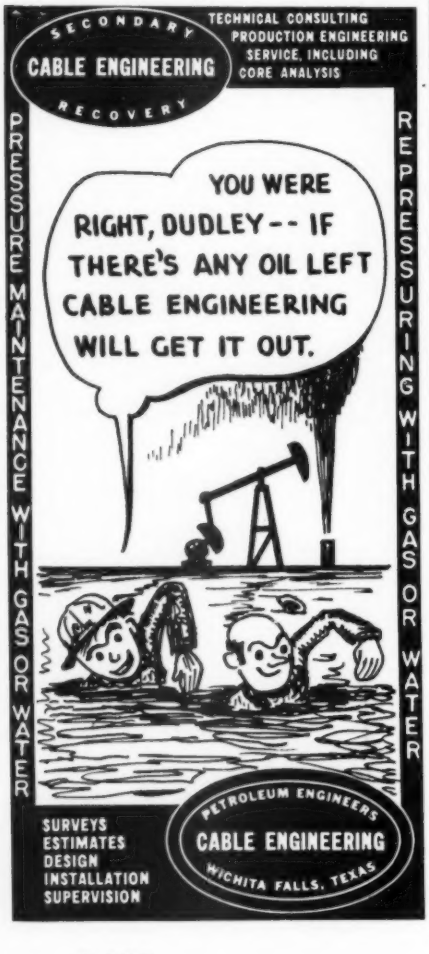
★ The discovery of an Ellenburger pay in the shallow Payton field of Ward County, has been reported by Cities Service.

This is the second major pay discovered by Cities Service in this field in which the company has majority interest and is the unit operator. Devonian pay was discovered in the joint-interest Payton No. 1 about a year and a half ago.

Cities Service has 2250 net acres in the vicinity of the Ellenburger discovery. Nearest Ellenburger gas production is in the Santa Rosa pool, four miles to the south.

On drillstem test of its wholly-owned Brandenberg "B" No. 1, between 10,084 and 10,165 ft, the well produced 14.79 bbl of 58.8 deg oil in one hour.

Flow was through one-inch chokes and the gas volume was at a daily rate of 6,154,000 cu ft. Flowing tubing pressure was 475 lb, initial flowing pressure was 1325 lb, final flowing pressure 1700 lb and the 30-minute shut-in pressure was 4775 lb.



COLORADO

★ Charles H. Osmond has made a bid for a new pool in the Denver-Julesburg basin at the No. 1 Dier in Weld County. Drill stem test taken between 6730 and 6860 ft showed 100,000 cu ft of gas and recovered 90 ft of free oil and 225 ft of gassy oil-cut mud. Formation tested was identified as the Pierre shale, produced in the Boulder field 15 miles west of this location. Drilling operations are still under way, with last report showing depth below 7400 ft.

UTAH

★ A new pay zone has been opened by Continental Oil in the Chapita Wells area of Uintah County. The Unit well No. 2 was completed at a plugged back depth of 5210 ft after reaching a total depth of 9125 ft. Initial potential test flowed 4618 Mcf of gas through open 2-in. tubing with perforations in casing at 5052-84 ft into the Green River.

★ Shell has made another wildcat strike in southeastern Utah near the Four Corners area.

The well, North Boundary Butte No. 1, produced a strong blow of gas during a 17-minute drill stem test in the interval 4662-4784 ft that was rated at 1160 Mcf per day. A plugged tester head haulted the test. Drilling crews then disconnected the tester and the well blew oil and gas for another 17 minutes, after which 630 ft of fluid was recovered containing 6.7 barrels of 40 deg greenish brown to black oil with a small cut of sulfur water.

Initial flow pressure of the well was 1215 lb per square inch with shut-in pressure of 1650 psi.

KANSAS

★ Shamrock Oil and Gas brought in a Clark County gas discovery from the Morrow sand topped at 5190 ft. The wildcat, Shamrock No. 1 Stephens H, gaged 14,000,000 cu ft of gas daily from perforations at 5194-211 ft. The well is in Clark County.

LOUISIANA

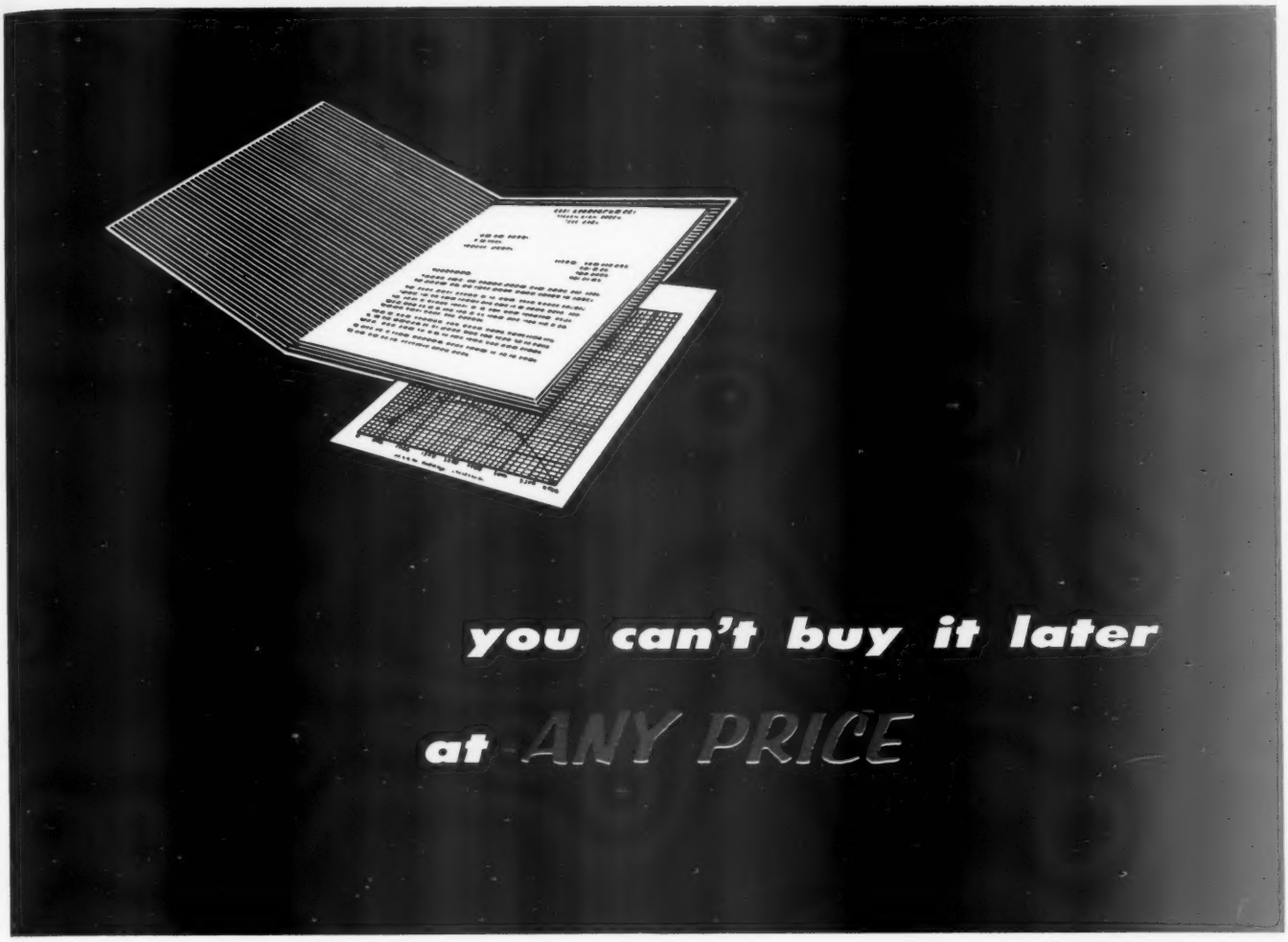
★ Continental Oil's State Lease 983 No. 1-A has been completed at a plugged back depth of 11,885 ft as a successful Miocene gas-condensate well. Initial potential of 1863 Mcf of gas and 244 bbl of condensate daily through 11/64-in. choke was recorded. Gravity reading was 53 deg, and tubing pressure was 4200 lb. Seven-inch casing was set at 11,885 ft, and 3½-in. liner went to 13,120 ft. Total depth of the well was 14,580 ft, and is located nine miles west of nearest production.

SUMMARY OF DRILLING ACTIVITY FOR FEBRUARY

(As Compiled by Rinehart Oil News Staff)

States	New locations		Wildcat completions			Field completions			Junked & abnd.		Temp. abandoned		Abandoned locations		Current active wells	
	Wc	Field	Oil	Gas	Dry	Oil	Gas	Dry	Wc	Field	Wc	Field	Wc	Field	Wc	Field
Alabama	3	0	0	0	7	0	0	0	0	0	0	0	0	0	5	1
Arizona	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Arkansas	7	33	1	0	10	21	0	8	0	0	1	0	0	1	11	16
Canada (Williston B.)	9	39	2	0	16	30	1	5	0	0	0	0	1	2	14	1 19
Colorado	64	54	3	1	49	24	0	19	0	0	0	0	0	1	61	48
Florida	3	0	0	0	3	0	0	0	0	0	0	0	1	0	3	0
Georgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Idaho	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Kansas	75	269	12	3	59	160	28	70	0	0	0	0	0	1	67	389
Louisiana	29	235	1	1	29	145	25	42	0	1	0	3	3	3	57	226
North	10	126	0	0	16	88	10	15	0	0	0	1	2	1	8	51
South	19	109	1	1	13	57	15	27	0	1	0	2	1	2	49	175
Mississippi	11	24	2	0	13	14	1	8	0	0	0	0	0	1	19	28
Montana	5	18	0	0	11	10	1	7	0	0	0	0	1	1	21	25
East	2	6	0	0	4	3	0	1	0	0	0	0	0	1	5	10
West	3	12	0	0	7	7	1	6	0	0	0	0	1	0	16	15
North Dakota	1	9	0	0	1	4	0	2	0	0	0	0	1	0	5	21
Nebraska	21	29	2	0	19	9	0	5	0	0	0	0	0	0	18	47
New Mexico	17	127	4	2	8	50	17	7	0	0	1	0	0	2	38	155
Eastern	12	96	3	2	7	50	6	4	0	0	1	0	0	2	30	115
San Juan	5	31	1	0	1	0	11	3	0	0	0	0	0	0	8	40
Oklahoma	46	563	3	3	32	360	16	130	0	1	1	8	0	23	63	439
South Dakota	1	2	0	0	0	1	5	0	0	0	0	0	0	0	2	0
Texas	497	1483	57	20	357	878	54	233	4	5	14	11	27	73	440	919
East Texas	23	43	2	0	14	25	6	13	0	0	0	0	1	2	30	54
Gulf Coast	30	116	1	7	43	68	7	27	0	1	1	0	0	2	33	93
North Texas	121	319	18	0	94	191	6	73	0	1	1	1	1	6	75	116
Panhandle	8	75	0	0	1	69	10	5	0	0	0	0	0	5	18	35*
South Texas	101	420	2	7	68	145	17	33	1	1	5	1	2	5	64	111
Border Co.	29	86	8	0	21	43	0	10	0	0	2	1	1	2	30	68
West Central	109	133	14	2	62	96	3	48	0	1	1	1	17	25	54	48
West Texas	76	291	12	4	54	241	5	24	3	2	4	7	5	26	136	394
Utah	0	1	0	0	0	0	0	0	0	0	0	0	0	0	16	4
Wyoming	9	45	6	0	15	35	1	12	0	0	0	0	0	18	31	65
Totals: Jan.	766	2636	108	31	673	1618	197	479	4	2	14	14	26	85	878	2316
Feb.	798	2931	93	30	630	1745	144	548	4	7	17	22	34	126	877	2402
1955 Total	1564	5567	201	61	1303	3363	341	1027	8	9	31	36	60	211	—	—

* Figure Incomplete.



Dollar for dollar, a Core Lab Reservoir Fluid Analysis Report offers more tangible return than any other type of appraisal performed during the productive history of an oil field. If properly timed and applied, it provides a direct key to maximum reservoir revenue.

But you can't backtrack to obtain it. Because each reservoir has its own unique fluid characteristics, the development of comprehensive fluid data must be completed during *the early life of key wells* — before any appreciable pressure decline.

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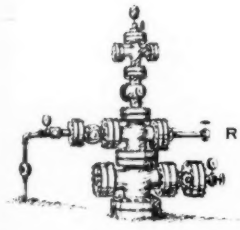
Ordinarily, the crossroad for this phase of reservoir engineering is reached within a few months, depending upon the size and nature of the reservoir. *You can never be too early.* Call Core Lab today.



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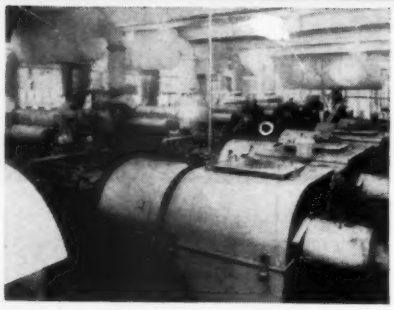
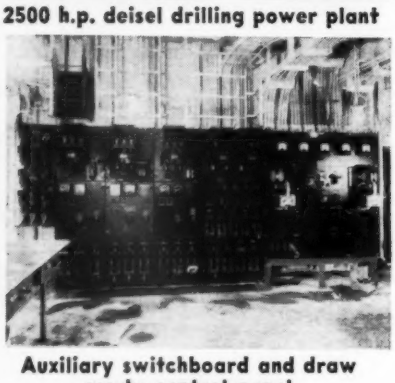


2500 h.p. deisel drilling power plant



Auxiliary switchboard and draw works control panel

Christening Ceremonies

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Another!

American Tidelands 101, deep water drilling barge designed and built by Alexander Shipyard, takes to the sea 10 months after starting date. The two million dollar giant becomes another marker in Alexander's leadership in offshore design and construction. American Tidelands 101 displaces over 4,000 tons, is 200' x 74' x 92' (from hull to helicopter deck), is capable of drilling in waters up to 45 feet deep and accomodates 40 men in modern air conditioned quarters.

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PIONEERS IN OFFSHORE DESIGN AND CONSTRUCTION

CALIFORNIA

★ Honolulu Oil Corporation is preparing to drill a wildcat in the much ignored Delta Farms area northeast of Coalinga in Fresno County. The venture is Indian-Westates No. 25, on Sec. 8, 19-17 and plans call for drilling through the Eocene sand expected at around 11,000 ft.

★ Edwin W. Pauley and Donald Frankel are expected to drill another joint test in the Del Rey area of Los Angeles County, on its 2000 acre lease. Two tests have already been taken down by the pair from location at the intersection of Lincoln and National Blvds., the first reaching a depth of 8725 ft and the second reaching a depth of 7972 ft.

★ Humble Oil & Refining is expected to drill a deep exploratory well at Semi Tropic, nine miles west of Wasco, California, where it has acquired a substantial amount of acreage. The area is near the site of a small gas field proved up by Standard Oil of California 10 years ago in the Vedder sand.

★ Los Nietos Company, subsidiary of Union Oil is drilling two follow-up tests to its recent discovery, Bourdieu No. 55-1 in the Coalinga area. The new wells are Bourdieu No. 75-1, two locations east of the discovery well and Sanger No. 44-1, a northwesterly offset. Standard Oil Company of California is drilling a northeasterly offset to the Los Nietos discovery and 2½ miles to the north, T & T Oil Company and Santa Fe Drilling Company are drilling Guijarrel No. 8-24. The discovery well has been averaging a daily productive rate of 1500 bbl since its completion.

★ Exeter Oil Company completed its Murphy Fee 14-J in the Midway-Sunset area of Kern County for a new zone discovery. Production is in excess of 200 bbl daily of 28 deg oil from an interval between 3961-3988 ft.

★ Sunset Oil Company is preparing to drill a test in the Sunset Beach area of Orange County. The location is 350 ft northeast of Jack B. Crawford's No. 18 well, completed recently for 1000 bbl per day of 28 deg oil and 3,000,000 cu ft of gas daily. The well will be on one of three locations on a four-acre parcel held by Sunset and is expected to drill to about 6800 ft.

★ Intex Oil Company is preparing to spud a wildcat on land leased from Joel McCrea in the Moorpark area of Ventura County. The well, McCrea No. 1 will be located on the southeast quarter of Sec. 27, 2n 19w and is expected to probe to a depth of around 5000 ft.

★ Intex Oil Company has abandoned Dearinger No. 46-23 on Sec. 23, 25-24 in the Pond area of Kern County. The wildcat explored, without results, to 10,865 ft, with interests being shared by Pacific Western Oil Corporation, Superior Oil Company and Fred Goodstein.

★ The Texas Company has staked location for a wildcat, Baker-Hunter No. 2, on Section 31-4n-18w, in the Torrey Canyon area of Ventura County. The drill site is 900 ft southeast of Baker-Hunter No. 1, drilled to 12,518 ft and abandoned by Texas Company last June.

★ Reserve Oil & Gas Company has started two new wells in the Tejon Ranch area of Kern County. Reserve E. W. Pauley No. 34-33, on Sec. 33-11n-19w, will explore to the JV sand while Reserve-E. W. Pauley No. 34-34, on Sec. 34-11n-19w, will test the Olcese sand.

★ Tide Water Associated is drilling on Sec. 30-21, in the Northwest Belgian Anticline field in a continued development program of its fee property in the area. Tide Water has completed five excellent producers on the lease.

★ Richfield Oil Corp. is drilling ahead below 11,513 ft at San Emidio B-2, 1½ miles southeast of the Wheeler Ridge field, in Kern County, after recovering 5700 ft of gassy, salty fluid on a test of Eocene sand.

Reverse Circulation

BRINGS IN JUNK!

By reversing normal circulation to literally pull objects into the basket, the BOWEN JUNK BASKET assures complete single-run recovery of all bottom hole junk.

Circulating fluid is diverted through side passages in the barrel and against the full circumference of the hole. Here the fluid is deflected, moving all objects toward center. Fluid flows in a continuous stream to the center of the tool and up through the barrel to return ports pulling all objects through the catcher. This reverse circulation action assures more complete recovery of junk in the hole and eliminates misruns. *Full pump pressure can be utilized* because there's no danger of pressure bearing against and causing loss of the fish.

Comes in sizes from 3¾" to 17½" and is engineered to recover all types of bit cones used to drill hole sizes within its range.

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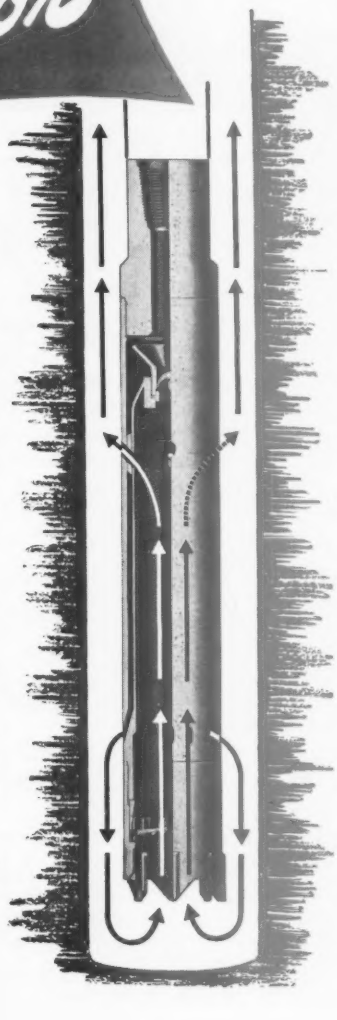

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What's doing in DRILLING

★The race is on in Canada with the spring thaws due in mid-April, to halt most drilling activity. Stanolind Oil and Gas, for instance, has 25 rigs under contract, 15 of these operating in Pembina. This company also has 7 wildcats underway in the Grand Prairie.

★At Huntington Beach, California, race of a different sort is still being run —to see who can get the most oil from the California hot-spot before reserves and pressures sink too low. Last official report stated that this area more than doubled any other in filing intention-to-drill notices. No dry holes were recorded in February or early March. Drilling may now reach out into Pacific tidelands.

★Word has been received that Arrow Drilling Company has moved its division office serving the East Texas, Louisiana, Mississippi and Arkansas from Tyler, Texas, to Shreveport, Louisiana. Lloyd Hanson, who was manager of the Tyler office has gone to home offices in Tulsa, Oklahoma, as drilling superintendent.

★According to the Hughes reports, the number of active rigs running this year is averaging about 50 per week higher than in 1954. Oklahoma legislature, however, seems pretty perturbed over the number of "rusting, stacked rigs" lying around.

★When these rigs show up, maybe someone will take a few to Florida, where Continental Oil Company is planning a healthy drilling program, originating in Highlands County. Conoco was last reported drilling in lime at 5000 ft on their first test. Lease play in that state is up sharply, despite recent failures by Humble and Gulf. Although Gulf has tried several wells in the Keys, it is now working on a 12,500 ft test offshore on southwest tip of the Florida mainland.

★Additional rigs will be needed in the Rocky Mountain region, if predictions hold true. Reliable sources foresee over 5000 completions in the area in 1955. Last year's completions totaled 4200, against 1000 finaled in 1949. Constantly increasing activity has been due to increased pipeline construction throughout the Rocky Mountain states.

★Hollywood cameramen have turned up photographing Aramco's oil activity near Dhahran, Saudi Arabia. Crews are filming Cinerama's latest movie.

★Irony of all this is that Sun Drilling Company, under contract for Universal Consolidated Oil Company, has begun drilling its No. 5 well on the Twentieth Century-Fox lot in downtown Los Angeles. Successful completion of No. 4 as a gas-condensate producer was made last month.

★While the photographers are on the other side of the globe, Sun is going to no end of expense to keep the rig in its own backyard quiet. In agreement with promises made to the Los Angeles City Council, the rig is completely enclosed with plastic sheeting for sound-proofing. The National Ideal drawworks and pumps are all electrically powered to further keep the operation hush-hush.

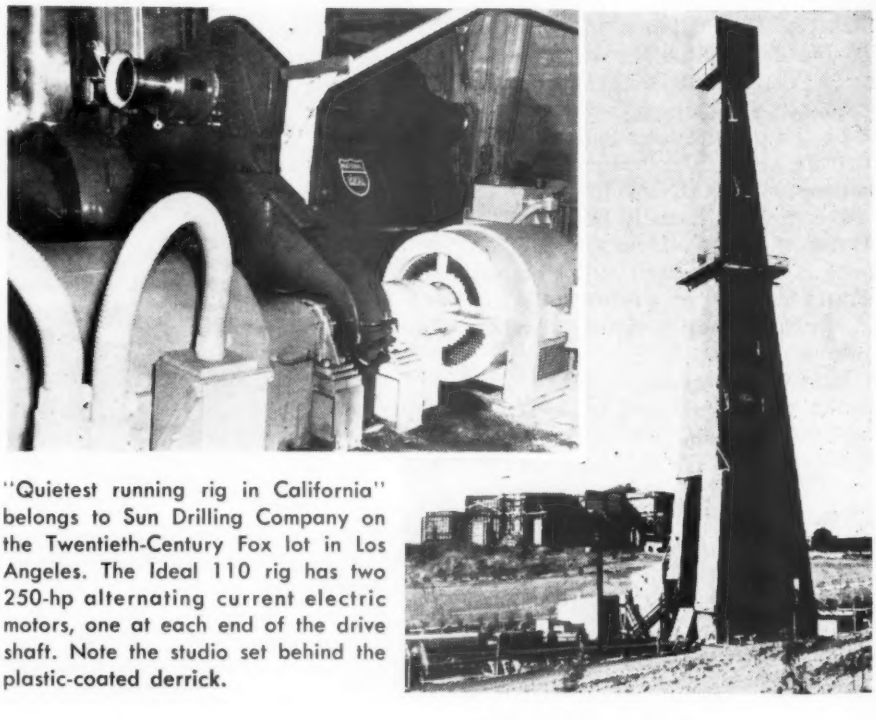
★Maybe it is just coincidence, but this drilling in Los Angeles, Huntington Beach, and other urban areas may be contagious. We hear that Amon Carter has begun drilling on a deep test that is nearer to Fort Worth, Texas, city limits than its own Amon Carter airfield.

★Next door, Magnolia has spudded a 9000-ft test in Dallas County and 5 miles from the Dallas city limits. This county has no production at the present time.

★In Tulsa, Lincoln Salee brought in a 200-bbl per day oiler for the trio of Twyman-Weaver-Nelson just 2000 ft from the city limits nearest Reservoir Hill. This latest addition, designated the No. 7 Osage, puts production north, east and southwest of the Tulsa metropolitan area. Depth is about 1250 ft in the Red Fork formation.

★Before we forget that drilling is still going on in less accessible locations we call attention to spring arrival of the first drilling crews out of the tall timber of western Colorado and Utah. There to augment the drillers, derrickmen and helpers for every rig is a cook and helper. Phillips men, operating on a ten-day on — five-day off schedule through the winter, have brought some encouraging news of a new pay in the Morrison (?) at their No. 1 Hell's Hole in Rio Blanco County. This well is still drilling past the 9400-ft mark.

★The bit peddlers, we understand, received over $2,000,000 of Phillips Petroleum's money last year.



"Quietest running rig in California" belongs to Sun Drilling Company on the Twentieth-Century Fox lot in Los Angeles. The Ideal 110 rig has two 250-hp alternating current electric motors, one at each end of the drive shaft. Note the studio set behind the plastic-coated derrick.

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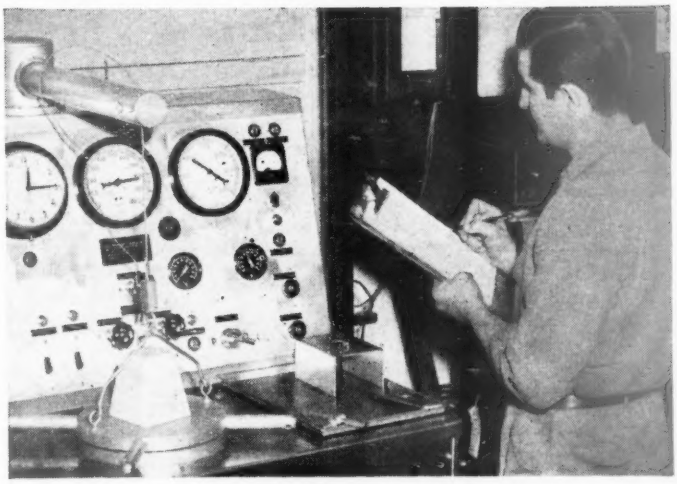
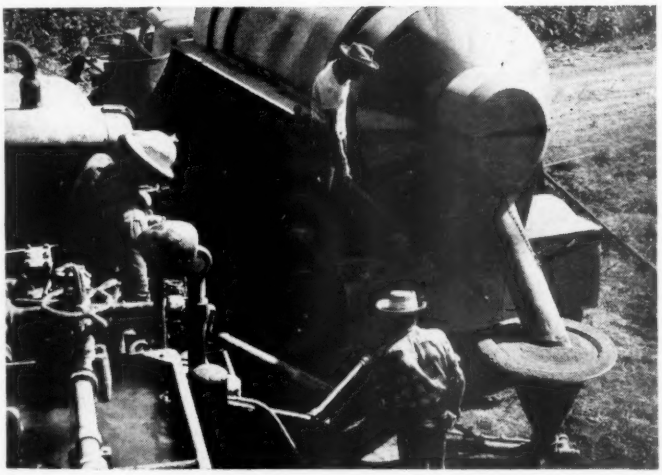
You can be sure of quality when you specify Unaflo Oil-Well Cement. Expert technicians regularly make many tests of Unaflo throughout its manufacture and also in our research laboratories over a wide range of simulated well-bottom pressures and temperatures. Such tests are just one phase of a continuous program of Unaflo quality-control and research to maintain and improve its performance.



means you can rely on Unaflo* at the BOTTOM



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All tests are made according to the latest API Recommended Practice for testing Oil-Well Cements.

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Unaflo *Retarded* Oil-Well Cement
Resistant to Sulfate Waters
Atlas Portland Cement — Type I

Atlas Portland Cement — Type II
Resistant to Sulfate Waters
Atlas High-Early Cement — Type III

PE-U-131R

Rotary Rigs Operating in Oil Fields of United States and Canada*

	Feb. 21	Feb. 28	March 7	March 14
Pacific Coast	145	150	147	145
Oklahoma	298	286	307	326
Kansas	183	184	179	181
Rocky Mountains	202	195	193	192
Canada	208	198	200	208
Ark-La-Tex	172	154	166	174
West Texas and New Mexico	508	486	505	522
Gulf Coast	538	543	552	575
Illinois	121	106	96	124
North Texas	330	320	340	335
Total	2705	2622	2685	2782

*As reported to the American Association of Oilwell Drilling Contractors by Hughes Tool Company.

★ Drilling difficulties haven't been surface deep, either, Oklahomans remind us. In the currently active Eola area, major faulting is presenting the headaches. Several good wells have been finaled recently in the Basal Bromide and Basal McLish in this crooked-hole country. These two formations, producing at depths of 10,000 to 11,000 ft, can be seen at the surface 15 miles away. Big Chief Drilling Company is breaking in a big new rig for Sohio in the vicinity.

★ Thirteen may be the lucky number, at least for Texaco. Its Louisiana tidelands Barateria Bay State Lease 356 well No. 13 is shaping up as the deepest producer in the world, if the rumors are to be believed. Last reports show a depth of 18,503 feet with well still testing. The well is in the Queen Bess Island area out from Jefferson Parish.

★ Another well that is being redrilled pretty regularly over the coffeecup, but not for its depth, is one on the University of Oklahoma campus at Norman. Students have constructed a one-tenth scale working model of a Lee C. Moore jackknife rig that so far has made 32 ft of hole. Occasion is annual Engineers open house sponsored by the Engineers Club on April 22 and 23. Several companies are planning exhibits.

★ Judging from the scarcity of casing pipe, even though the steel mills are operating at near capacity, not only are holes being drilled in great number, but wells are being made. Most supply houses, at least in the Mid-Continent, are taking orders for strings of pipe for delivery in June.

★ With all this talk about good completions always come records of individual achievement along this line. Most notable one that we've heard about in a good while is by Skelly in its Flowers field, Stonewall County in West Texas. The company has completed 105 good wells without a single dry hole. The wells produce from the Upper Canyon sand (Pennsylvanian) at an approximate depth of 5000 ft. Reports are that Skelly still is completing one well about every 20 days or so, with about 20 locations left.

★ Christie, Mitchell and Mitchell, who have leased section after section of land in Jack and Young counties, Texas, have established a record of 52 wells without a dry hole. The firm is developing this area primarily for gas. To date it has brought in enough of the stuff to warrant consideration of a 350-mile pipe line across the northern part of the state. The Houston company claims to have spent $3,500,000 on its properties and expects to spend "much more."

★ Sunray Oil Corporation, is developing a gas field in Glenn County, California. At present it has six wells shut in, pending completion of a pipe line to Beehive Bend, Sacramento Valley gas field. The company plans to drill 10 development wells on its holdings extending over several thousand acres. As a result of geological information which indicates substantial potential reserves, three wells are to be drilled immediately. These are the Whyler-Michael Unit well No. 1, Whyler-Walcott Unit well No. 1, and the Whyler-Moutrey Unit, well No. 1, all located in the vicinity of the presently producing Rheem-Zumwalt well No. 2.

★ Drilling and Exploration Company, with home offices in Houston, has announced the purchase of Crescent Drilling Company of Monroe, Louisiana. Equipment sold for the consideration of $1,300,000 included ten rigs and transportation equipment.

★ "Which came first, the chicken or the egg," question exists in the development of refineries, pipe lines and leasing and exploration activities in Washington and Oregon. Regardless of the solution, the fact is that there is plenty of activity in all segments of the industry in the Pacific Northwest. Lease play is heavy both adjacent to the Pacific Oregon and inland.

★ The Oroco Oil and Gas Company has quit its No. 1 Bolles, a rank wildcat in Malheur County in the eastern part of Oregon. A previous well, drilled by the same outfit, revealed two gas zones, one at about 1450 ft and another at 1750 ft.

★ Ray Ranger, a Houston independent, will also sink a test well in Oregon soon on a farmout by Sinclair Oil and Gas. Sinclair holds a block of some 45,000 acres in Malheur County.

★ Activity in the western section of the country is not restricted to Oregon, however. California is being kept busy on almost every front. M&M Oil, Union, Richfield, and Tide Water are active in the coastal state. M&M is offsetting Delaney-Tunnell 11-X in West Cat Canyon area with Canfield 18. In the same area Union finaled Bell 119 for 160 bbl per day. Richfield is drilling ROC-KCLC 63-28, offsetting the successful 52-58 (2024 bbl per day), and Tide Water completed Lloyd 179 for 1181 bbl at 12,818 ft in Ventura Avenue field.

FUNDAMENTALS OF ROTARY DRILLING

When completed the Drilling Fundamentals series now being published in *The Petroleum Engineer* will be a valuable and comprehensive handbook of rotary drilling.

Don't miss clipping the installments in each issue . . . for your own personal reference file. Pages fit standard loose-leaf notebooks.

Drilling Fundamentals will include 55 articles written by those who know drilling operations and can describe them. Turn to **Page B-101** now and clip this month's chapters on **Drilling Fundamentals.**

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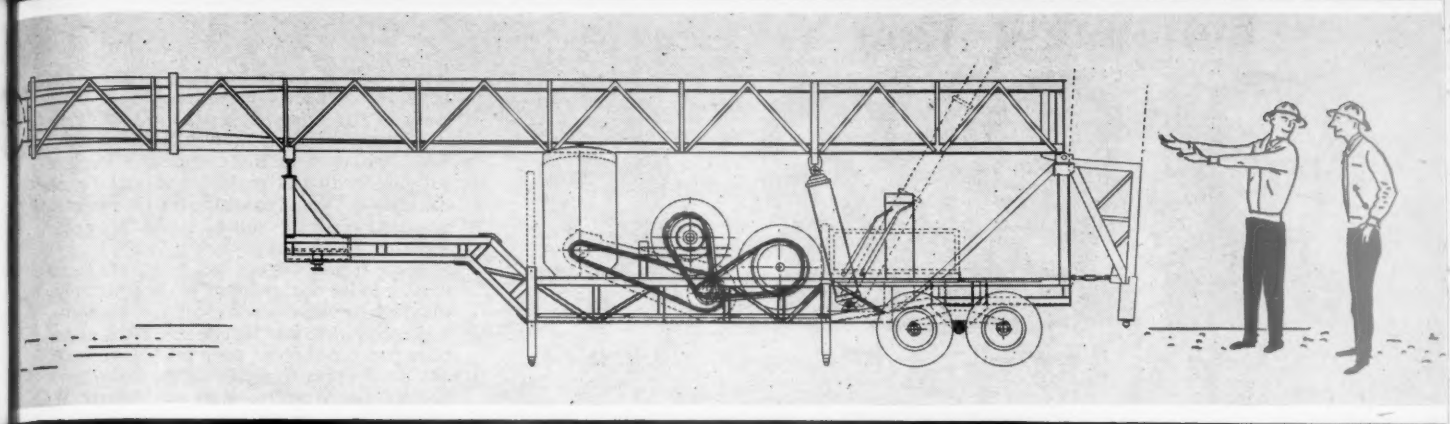
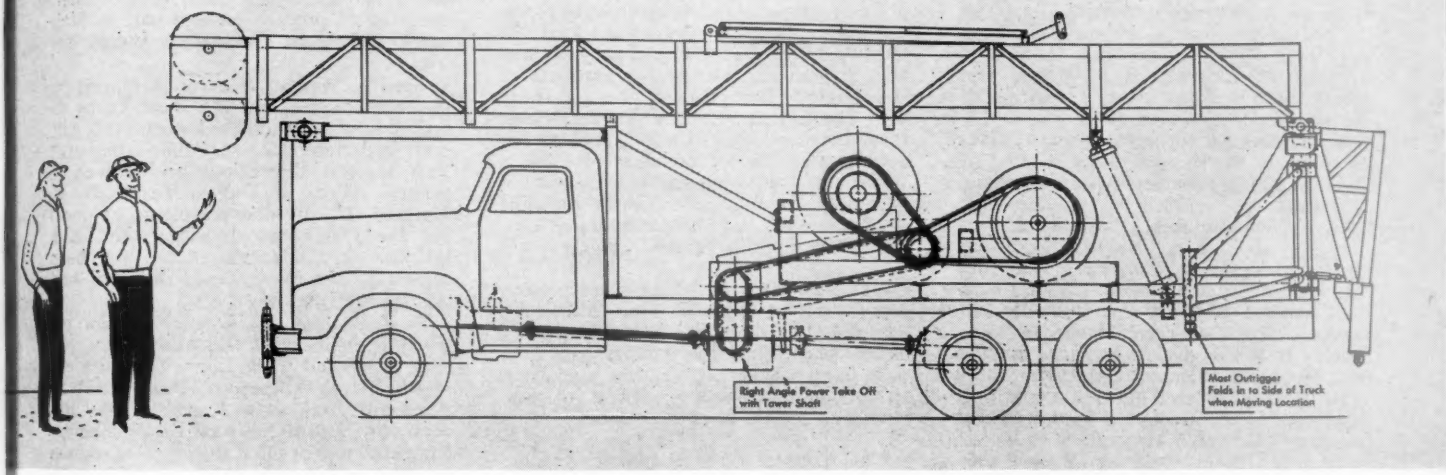


WILSON MANUFACTURES BOTH



Wilson built winches on trucks, with power-take-offs, of Wilson make as early as 1928, and several thousand of these were made, but these were discontinued just before the war because most customers preferred the separate engine.

Recent state restrictions on weight and size have forced well servicing contractors and other users to ask for a "good power-take-off" that will "stand the gaff" of rugged oil field service with a very minimum of "down time" and maintenance cost. We have now designed, field tested and proved what our customers have told us is "*the best heavy-duty truck power-take-off ever built.*" It incorporates many new features never before available in any power-take-off and is built so that is can be used in any make or size of heavy truck.

For the first time users can now obtain a *Modern* High Capacity Mast, with a *Modern* Heavy Duty Air Tube Clutch Drum Winch, with High and Low Clutch drum speeds, and new lightweight clutches which never need adjustment; with this truly *Modern* "1954 Model" Power-Take-Off! And these new units are legal as regards to length, width and height, and *weight distribution!* The Super 38 Double drum units with tubular masts and the usual amount of lines and tools can be made legal in most states. Fabricated Masts on *double drum* units with lines and tools may require permits.

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The HOME of RED IRON • WICHITA FALLS, TEXAS

RUNNING TOUR with MEN in the INDUSTRY

G. B. Gariepy

R. M. Wilson

R. A. Koenig

T. K. Bowles

Glen B. Gariepy has been appointed chief geologist for The Ohio Oil Company. He succeeded **Paul L. Henderson,** who has been elected a director and vice president of production. **R. M. Wilson** succeeded Gariepy as assistant manager of the company's Shreveport, Louisiana, production division.

Ralph A. Koenig, division geologist of the Tulsa, Oklahoma, division, has been appointed division geologist at Shreveport. Koenig succeeded **R. M. Wilson** who advanced to assistant division manager of the Shreveport division.

T. K. Bowles, formerly assistant chief geologist in the general office located at Findlay, Ohio, became division geologist at Tulsa.

G. R. Schoonmaker, Ohio Oil's district manager at Calgary, Alberta, has been appointed assistant manager of the foreign division. Succeeding Schoonmaker in the Canadian post is **C. W. Donnelly,** division geologist at Terre Haute, Indiana. **Stanley B. White,** district geologist at Casper, Wyoming, replaced Donnelly.

Dr. R. Dana Russell has been appointed supervisor of the geological section of the company's Research Laboratory to be located near Denver, Colorado. Russell was previously senior consultant in geophysics and chairman of the Scientific Planning Board at the Navy Electronics Laboratory on Point Loma, San Diego, California.

Ralph C. Farley has been named general superintendent of production at Findlay. He has concluded 21 months on special assignment in charge of production for the Tide Water Group, active in Saskatchewan, Canada.

John Post, manager of the industrial relations department of Continental Oil Company, Houston, Texas, has accepted membership on the newly created Board of Industrial Advisors of the Occupational Health Institute. The Institute is a nonprofit organization established to guide industrial managements in the development of health maintenance programs and aid in dealing with problems of employee health.

L. H. Porter has been appointed manager and **F. E. Wimbish** chief of exploration of Socony Vacuum's newly formed exploration company in Portugal. With the recent signing of an agreement in Lisbon, Portugal, Socony-Vacuum has undertaken exploration in that country as contractor with a participating interest in the benefits of a concession held by Companhia Dos Petroleos de Portugal. The venture will be conducted in the name of the recently formed Delaware subsidiary, the Socony-Vacuum Exploration Company, with offices in Lisbon.

Four personnel changes in the geology department of Tennessee Gas Transmission Company have been announced. **Francis B. Stein** has been promoted to assistant chief geologist and transferred to Houston, Texas. He previously was acting division manager at Wichita Falls. **J. Spencer Collins** has been promoted to division geologist and transferred to Houston from Denver, Colorado. **Earl G. Griffith** has joined the company as district geologist in Denver. A graduate of Washington State College, he has been with The Chicago Corporation in Denver as division geologist. **Carl E. Jenkins** has been named district geologist at Casper, Wyoming. A graduate of the University of Wyoming, he had been district geologist for Sinclair Oil and Gas Company at Casper before joining Tennesseee Gas.

Henry H. Neel has been named division exploration manager of Tide Water Associated Oil Company's western division. Neels, who joined the company in 1942 as a fossil washer at Ventura, had been serving as divisional geologist at San Francisco before his promotion.

Basil Kantzer has been appointed acting manager of operations for the Gulf Coast division of Union Oil Company of California with headquarters in Houston, Texas, relieving **Dudley Tower** who has been granted a temporary leave of absence.

E. T. Asplundh has been elected a director of Southern Minerals Corporation, an oil and gas producing firm with headquarters at Corpus Christi, Texas. He is also president of Columbia-Southern Chemical Corporation, a wholly-owned subsidiary of Pittsburgh Plate Glass Company, a director of Pittsburgh Plate Glass Company, and president of Standard Chemical, Limited.

F. A. Menken and **W. E. Dillon,** former officers of the Tide Water Associated Oil Company, have opened petroleum consulting offices in San Francisco, California. Both men recently retired from the company.

J. H. Todd, former manager of the exploration department of Standard of Texas, has been appointed a director and elected a vice president of the corporation. Todd has been affiliated with The California Company since 1942 and became associated with Standard of Texas in 1954.

H. H. Kuester also has been appointed a director and elected a vice president. Kuester has been manager of the land and lease division for the past nine years.

Kenneth R. Joynt has been promoted to assistant division superintendent of Magnolia Petroleum Company's Oklahoma producing division. Joynt has been district superintendent of the company's Pegasus producing district in Midland and Upton counties in West Texas. **Cletus H. Samples,** assistant district superintendent of the Pegasus district, replaced Joynt.

John Henry Myers has been advanced from production pumper to assistant production foreman in Wewoka, Oklahoma, producing district. **Joseph M. Huston** has been promoted from gang pusher to assistant production foreman in the company's district in Western Kansas. **Albert W. Shaw, Jr.,** has been advanced from assistant foreman in the Pegasus producing district to production foreman in the Panhandle district.

J. B. Merritt has been promoted from gang pusher to assistant production foreman in the Pegasus district. **E. L. Winterbauer** has been promoted from assistant foreman to production foreman in Magnolia Petroleum Company's Luling district.

Fred S. Wright, Jr., who has been petroleum engineer for the West Texas division, has been promoted to assistant general superintendent of the company's Part Interest Operations and moved to general offices in Dallas, Texas. **H. K. Holland, Jr.,** division petroleum engineer for the Oklahoma division with headquarters in Oklahoma City, has been moved to the West Texas division, succeeding Wright.

D. F. Pendley, Jr., assistant division petroleum engineer at Oklahoma City, has been promoted to division petroleum engineer there. **William A. Daniel,** district petroleum engineer at Kermit, Texas, has been advanced to assistant division petroleum engineer of the company's Oklahoma division with headquarters in Oklahoma City. **V. M. Leonard,** district petroleum engineer at Duncan, has been moved to Kermit, Texas, as district engineer there.

Charles L. Barney, petroleum engineer in Magnolia's Pegasus district, has been promoted to district petroleum engineer at Duncan, Oklahoma. **W. L. Morris** has been transferred from the Petroleum engineering department at Kermit to the producing division as assistant production foreman there. **Forrest D. Musson** has been promoted from junior petroleum engineer to petroleum engineer at Magnolia Petroleum Company's Brownfield producing district.

Royal J. Christensen has been advanced from junior petroleum engineer to petroleum engineer in the company's Electra district. **A. J. McCredie** has been promoted from junior petroleum engineer to petroleum engineer in the company's Oklahoma Producing division offices at Oklahoma City. **Archie M. Speir** has been advanced from petroleum engineer at Lake Charles, Louisiana, to senior petroleum engineer in Magnolia's Gulf Coast division offices.

Owen H. Blexrud has been moved from district geologist at Wichita, Kansas, to Midland, Texas, succeeding **Forrest E. Wimbish. Asa D. McRae,** formerly district geologist at the Mount Vernon, Illinois, office, has been transferred to Wichita, Kansas, as district geologist in charge of the Kansas district. **Harold J. Fitzgeorge** has been moved from the Abilene district to Mount Vernon as district geologist.

SHOT in the right place... ...for best production!

"pin-point" accuracy, uniform hole pattern that gives equal coverage of all the productive zone, PLUS the most important factor of all... deepest penetration, gives you the results you want... MORE OIL!

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Latest McCullough advancements in the science of perforating are... improvement of the firing power of McCullough M-3 Guns and development of a new Ogival Bullet with tremendous penetrating qualities. You gain up to 50% deeper penetration than was previously possible. Results from field operations have proved the Glass Enclosed Jets to be the best jet perforating process.

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SERVICE ANYWHERE — ANYTIME

Running Tour

▸ **A. E. Brainerd** and **F. M. Van Tuyl,** Denver, Colorado, consultants in petroleum, economic and engineering geology, announce the affiliation of **C. C. O'Boyle,** geological engineer.

F. R. Wheeler

▸ **F. R. Wheeler** has returned after an absence of two years to head the engineering department of Chemical & Geological Laboratories, Casper, Wyoming. Wheeler became associated with Chem Lab in October, 1948, in the initial organization of the engineering department. He left in February, 1953, to enter a partnership in Abilene, Texas.

▸ **Henry C. England, Jr.,** has been appointed coordinator of safety for Sun Oil Company's production department. England, who has been safety and personnel man for Sun in Southwest Texas, with headquarters at Corpus Christi, will be succeeded at Corpus Christi by **O. Trotter Adams,** who has been safety and personnel man in the Midland district, West Texas.

▸ **William Ormond White,** Shreveport, Louisiana, has been elected president of Trans-Tex Drilling Company. **George S. Buchanan,** former president of Trans-Tex, was reelected chairman of the board. Trans-Tex, is a wholly owned subsidiary of Husky Oil Company, Cody, Wyoming.

▸ **Don Sweeney** has joined the Western Oil and Gas Association of Los Angeles, California, as a staff representative. Sweeney was formerly associated with General Petroleum Corporation.

Gilmore Thompson has joined the public relations staff of the association. Thompson was formerly associated with the United Press Association and was employed by Dave Foutz and Associates, a Los Angeles public relations firm, before he came to the association.

▸ Humble Oil & Refining Company has announced changes in its production department supervisory personnel. **Fred B. VanShoubrouek,** toolpusher, Odessa district, West Texas division, was promoted to assistant district superintendent at the Snyder district. **N. N. Jones,** district superintendent, Means district, West Texas division, transferred to the California area, Los Angeles, as area superintendent. **W. E. Diamond,** toolpusher, Grand Isle district, Louisiana division, was promoted to assistant district superintendent at the Paradis district.

J. M. Shepherd, district superintendent, Bakersfield district, California area, moved to the Means district, West Texas division, as district superintendent. He was replaced at Bakersfield by **J. F. Jeansonne,** formerly assistant district superintendent at the Wink district, West Texas division. **J. P. Baldridge,** assistant district superintendent, Snyder district, West Texas division, replaced Jeansonne at the Wink district. **D. C. Rhodes,** district superintendent, Goose Creek district, Gulf Coast division, was promoted to assistant division superintendent of the Gulf Coast division.

E. A. Auld, roustabout gangpusher, Conroe district, was promoted to farm boss at Conroe. **Eameal Holstien,** roustabout gangpusher, Friendswood district, was promoted to farm boss at Friendswood. **I. M. Sparkman,** roustabout gangpusher, Flour Bluff district, Southwest Texas division, was transferred as rousabout gangpusher to the Conroe district, Gulf Coast division. **Ezell Walston,** roustabout gangpusher, Imogene district, Southwest Texas division, was transferred as roustabout gangpusher to the Conroe district, Gulf Coast division, as roustabout gangpusher.

A. G. Harmon, roustabout, North Crowley district, Louisiana division, was promoted to roustabout gangpusher at North Crowley. **C. L. Sparkman,** toolpusher, Athens district, East Texas division, transferred to the Means district, West Texas division, as toolpusher. **J. C. Denney,** senior civil engineer, Southwest Texas division office, was transferred to the Louisiana division, Paradis district, as district engineer. **M. L. Shivers,** civil engineer in the Stratton district, Southwest Texas division, moved to the Louisiana division office as civil engineer. **R. J. Ridley,** civil engineer in the Stratton district, Southwest Texas division, was transferred to Louisiana Division, as civil engineer.

W. L. Hooks, district superintendent, Pollard district, Louisiana division went to the Livingston district, Gulf Coast division, as district superintendent. **E. E. Marshall,** district superintendent, Livingston district, replaced Hooks at Pollard. **J. L. Hackney,** senior gas engineer, Gas division office, Houston, was transferred to the Bayou Sale district, Louisiana division, as senior gas engineer. **J. T. Murff,** district civil engineer, Sugar Valley district, Gulf Coast division, transferred to the Avery Island district, Louisiana division, as district civil engineer. **J. G. Jackson,** Southwest Texas, moved to Louisiana division as senior petroleum engineer.

Adomite

A New Product With Big Possibilities— Continental Oil Co. has developed a new material—Adomite—which can be mixed in crude oil to lower the fluid loss so that the oil can be used as a fracturing fluid. Field tests have shown excellent results and the product has been placed on the market. The Chemical Process Co. distributes Adomite as part of our fracturing services.

When applicable, the use of crude oil rather than refined oil for fracturing offers substantial operating economies in addition to many completion advantages. By simply lowering the fluid loss, Adomite allows usual amounts of sand to be carried in thin crude oil without screening out. Thus without excessive fluid loss, the oil will afford a more extensive fracture. Lower injection rates also are possible, less equipment is required, wells clean up better and faster, and the sale of the oil is not affected.

The chances are that Adomite has an immediate place in the completion work you have under way. If you will write to The Chemical Process Co. in Breckenridge, Texas, or contact one of our many stations in the Mid-Continent area, we'll be glad to tell you more about Adomite and give you descriptive literature without obligation.

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SERVICING OIL & GAS WELLS

ACIDIZING FRACTURING

ADOMITE IS CONTINENTAL OIL COMPANY'S NEW ADDITIVE TO CONDITION CRUDE OIL TO USE AS A FRACTURING FLUID

Multi-Graded Oil. A new three-graded motor oil—spanning viscosity grades SAE 5-W to SAE-30—was recently announced by Sinclair Refining Company. Called "extra duty Triple X motor oil," the new oil carries the designation SAE 10W-30 and is recommended for 4-season service in all model cars where SAE 10W, SAE 20W-20 and SAE 30 grade oil are specified. SAE 5W-20 grade Triple X is recommended for severe, sub-zero winter driving where SAE 5W has been specified. The new oil is said to lessen frictional drag and the formation of combustion chamber deposits, and to have superior lubricating qualities.—EBB

★ ★ ★

Snell Buys Crippen-Ehrlich Labs. Purchase of the Crippen & Ehrlich Laboratories in Baltimore, Maryland, by Foster D. Snell, Inc., was announced recently. R. C. Crippen, former owner-partner, will remain as director and secretary-treasurer. The laboratories include facilities for fuel and oil testing, instrument laboratory, analytical, paint and varnish, pilot plant and other research and testing facilities.

★ ★ ★

Racers—No Runners. Not to be outdone by Milady's appropriation of the the synthetic fabric nylon as foot-covering, race horses are said to be wearing nylon shoes now, to lessen the total weight of their feet on the track. They have no seams to keep straight and the only runners are the horses themselves.

★ ★ ★

What Future for Inland Plants? The recent announcement of the projected closure of the Tide Water refinery at Drumright, Oklahoma, may well be a weather-vane for small refineries, in the opinion of informed observers of trends in the refining industry. This plant, of nominal 15,000 bbl per day crude capacity, with relatively new cat cracking and vacuum distillation facilities (1946), located centerwise in the Mid-Continent area has been operating since 1921, and its facilities have been modernized from time to time. The company has not announced the specific reasons for the closure plans. Many refineries of small-to-medium capacity have been having trouble meeting octane-rating competition, especially from large modernized refineries located on the seacoast, and at the same time staying on the black side of the ledger. The strong spurt in rising octane ratings in the last two or three years has accentuated these problems.

While automotive designers are producing engines calling for higher and higher octane rating fuels, these designers insist that the engines brought out at any given time will operate satisfactorily on regular, "housebrand" motor fuels with the exception of a few high-priced and ultra-powerful engines in the Cadillac-Lincoln-Packard class.

★ ★ ★

Thirty Million More. Marcus Hook and Houston, Texas, refineries of Sinclair Refining Company get the nod this time for the investment of $30,000,000 in new facilities. Houston gets a new cat reformer, presumably to use in the RD-150 Sinclair-Baker catalyst, and a sulfur recovery unit. The two will take up $20,000,000 of the chit. The remainder will build two 60,000 bbl per per day crude units, all to be completed sometime in 1956.

★ ★ ★

"Down Under" Water Saver. A thin film of cetyl alcohol over the surface of a body of water is said to reduce the evaporation loss by about 30 per cent from open reservoirs, so finds a research outfit in Australia. Cetyl alcohol can be obtained from whales, presumably can be synthesized; scheme costs ½ cent per 1000 Imperial gallons of water.

★ ★ ★

New LPG Sales Division. The Texas Company has organized a new liquefied petroleum gas division to handle sales of LPG in all territory east of the Rocky Mountains. Milton C. Lewis, head of this division, headquarters at Tulsa, Oklahoma.

★ ★ ★

New Chemical Company. Stanolind Oil & Gas Company has changed the name of its subsidiary that owns the synthetic gasoline plant at Browsnville, Texas, from Carthage Hydrocol Inc. to Hidalgo Chemical Company. The synthetic gasoline plant owned by Stanolind is being revamped and will be used to make raw chemicals that will be recovered and purified at the Hidalgo plant. R. W. Greeff & Company, New York, will be exclusive sales agents for the chemical production. The list of chemicals includes acids, alcohols, aldehydes, and ketones in the C_1-C_5 range, derived from Hidalgo County natural gas.

10-to-1 Ratios by 1960?. One hundred octane number motor fuels will be "must" within three to four years, says V. G. Raviolo of Ford Motor Company. Most cars will have 10-to-1 compression ratios, and will have 30 per cent higher horsepower ratings than at present, among the lower-priced units. "Corresponding increases" are predicted for the luxury-priced cars.

"This trend will result in one grade of gasoline by 1960-62," said Raviolo speaking before the API Lubrication Committee in Detroit, recently. Also, the gas turbine engine will be in production for specialty car power, he thinks. Turbine fuels will call for low volatility; lower costs. Synthetic lubricants, presumably of the types now being developed for aviation jet engines, will be required to meet the severities of the 500-650 F temperature of the turbines. High-speed reduction gears with extremely high unit loads will call for special lubricants. Wheel bearings will be sealed permanently, Raviolo thinks. Oh, for the beautiful simplicity of the Model T!

★ ★ ★

Super Zeolites. Adsorbing five to six times as much water vapor from gas as does silica gel or alumina, a new synthetic zeolite offers distinct advantages in the field of dehydrating the increasing hugh quantities of gas for interstate transmission lines. Another synthetic picks up straight-chain hydrocarbons from a mixture with iso-paraffins and others of the more complicated molecular structures. Chemical composition is not yet revealed.

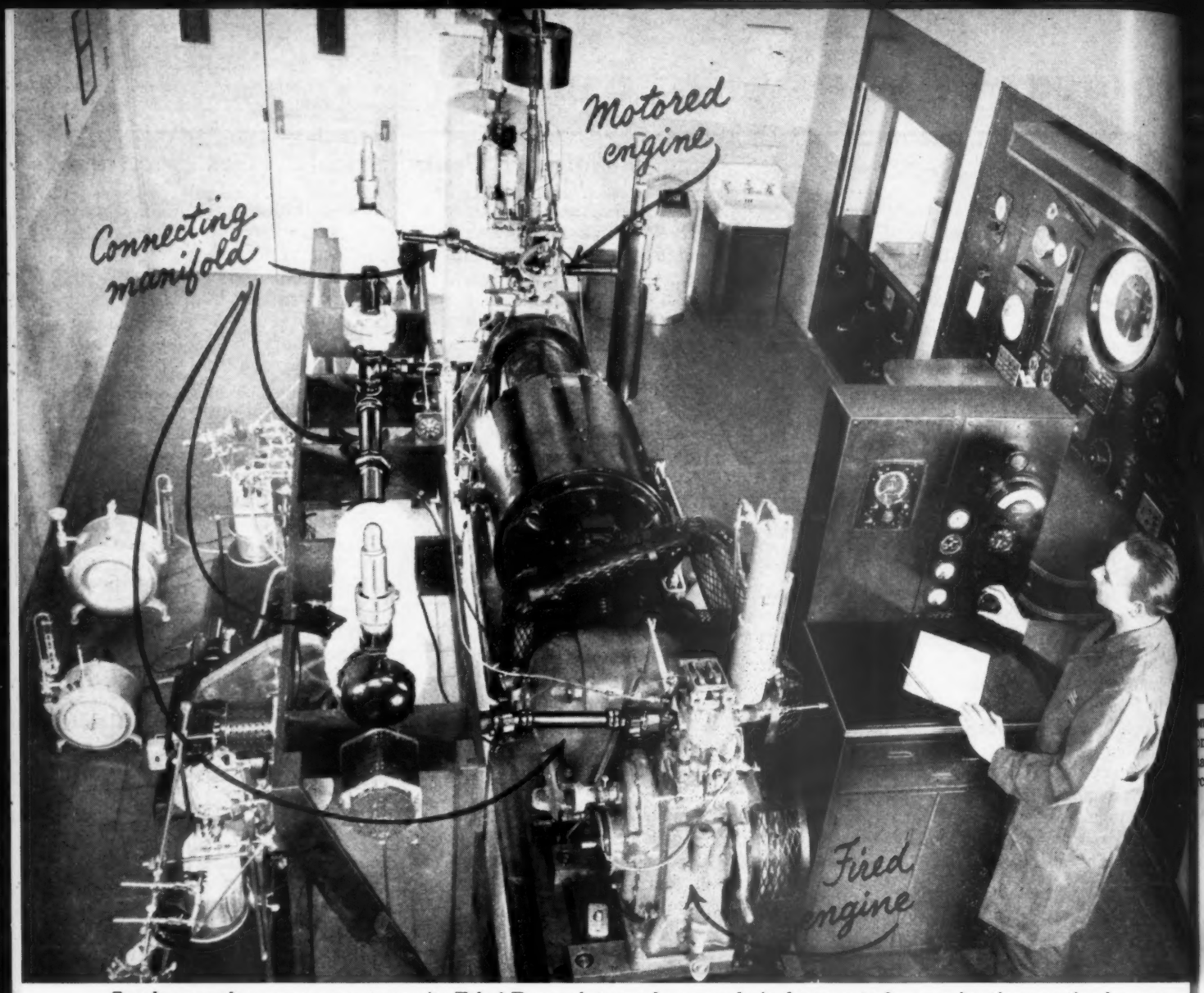
★ ★ ★

Texas Taxes Gases. Nothing is so persistent as the tax gatherer, except the tax levier. Supreme Court threw out Texas' earlier natural gas tax law; now another Ford (Rep. Curtis) brings three bills before Texas legislature: (1) to levy a 1½ cent production tax; (2) force producer to pass this tax on to purchaser when gas price is below 10 cents; (3) if this bill is unconstitutional then establish a minimum market gas price of 12 cents, enforce this provision on basis of economic waste.

★ ★ ★

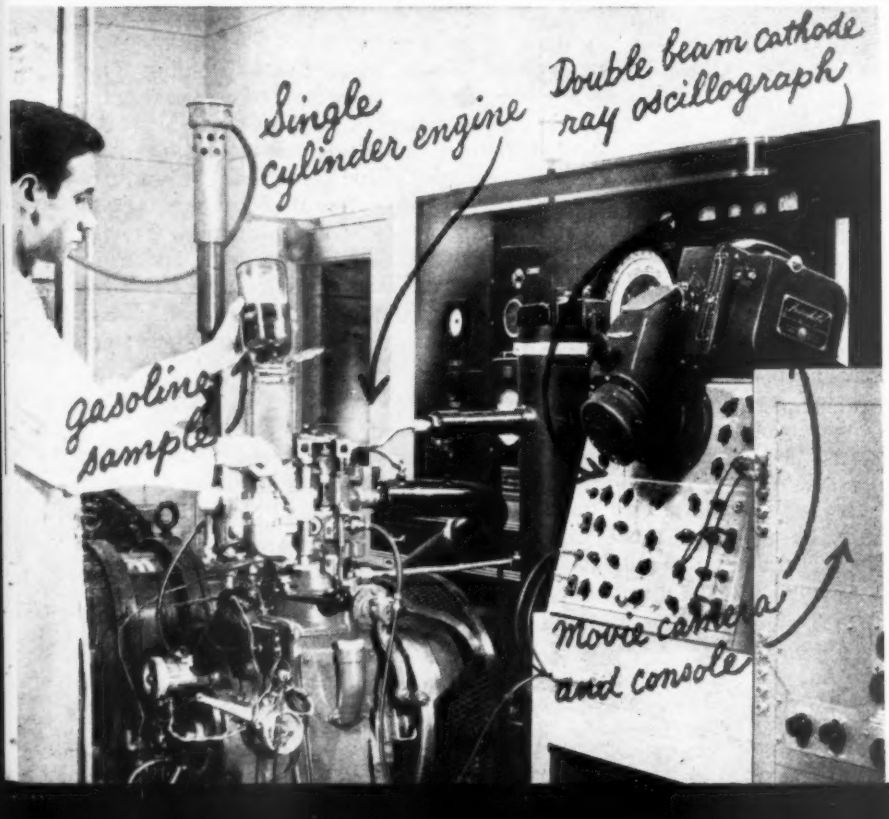
"Clock Spectroscope. An atomic clock that operates in the microwave frequency range and that can be used as a spectroscope to study structure of molecules, analyze materials, and other special applications has been developed. Incidentally, this clock is said to err by not more than one second in 300 years!

XUM

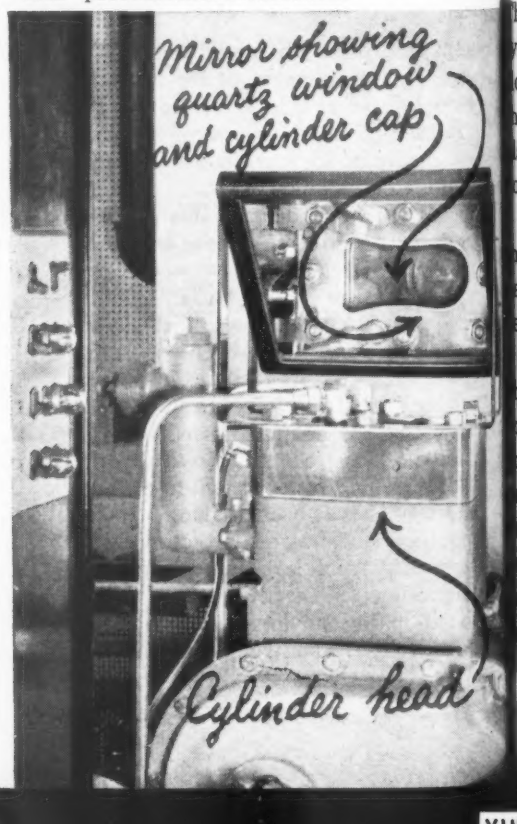


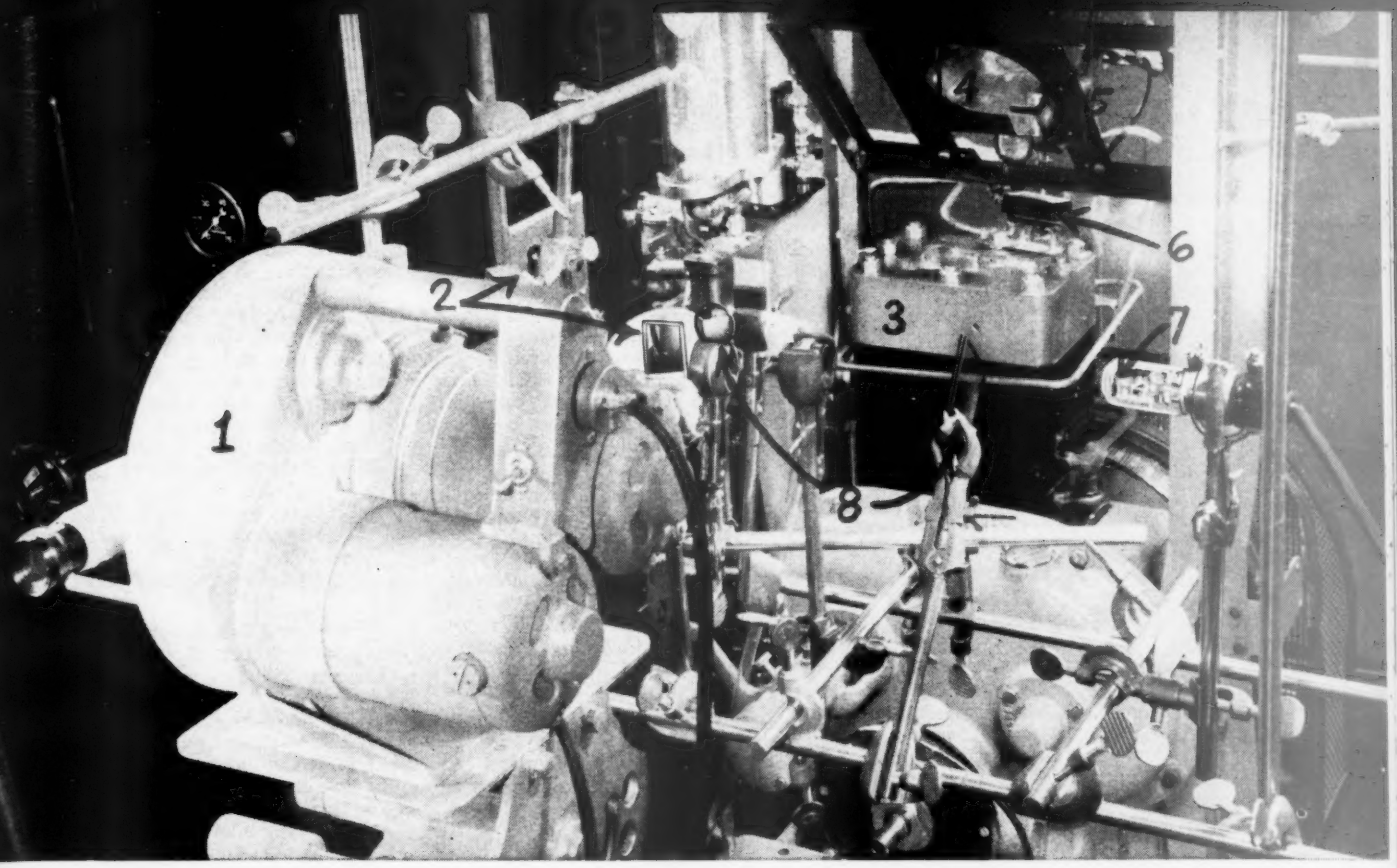
Tandem engine arrangement permits Ethyl Research to produce any desired amount of precombustion reaction by varying compression ratio in a motored engine. The effect of precombustion on knock can then be evaluated in the second engine.

Pressure-time records of modern high-speed engines require expensive and intricate instrumentation like that below.



Direct view of quartz head shows how camera "sees" precombustion reactions.





mplex arrangement of lenses and mirrors permits camera to photograph "cool" flame in engine cylinder utilizing varia-ns in the refractive index of the hot gases. 1. Fastax high-speed movie camera. 2. Mirrors. 3. Cylinder head equipped with artz window. 4. Mirror showing light reflected from piston top. 5. Synchronizing light. 6. Timing light. 7. Light source—conium arc. 8. Optical filters.

Ethyl Research takes a look at precombustion

he instant an air-fuel charge is pulled into the ylinder things begin to happen. The intake valve oses, compression starts—and even before the harge is ignited—important chemical changes take lace in the fuel. Just what are these changes? How o they affect the operation of the engine?

Ethyl Research people have been pioneering in is unknown area for years. In their studies they ave developed several new techniques, which are elping to fit together the answers.

Among these is a precombustion ("cool" flame) notographic setup using shadowgraph techniques. this instrumentation a complicated series of lenses d mirrors is arranged so that a high-speed camera pable of 7200 frames a second can photograph cool" flames in a special test engine. At the same me it picks up flywheel timing marks. A second mera—synchronized with the first—photographs stantaneous pressure traces from the oscilloscope. In this way "cool" flame and pressure records can be precisely correlated.

Another of these special Ethyl instruments is the tandem engine. Here precombustion reactions of different degrees can be made to occur by varying the compression ratio of a motored engine. The reaction products are then rated in a fired engine to find the direct influence of the early reactions on knock.

By analyzing various test results, Ethyl Research has developed a better understanding of precombustion reactions, and thus has added to the general knowledge of the combustion process.

These precombustion studies are an important part of "Ethyl's" basic research program.

ETHYL CORPORATION
Research Laboratories

1600 West Eight Mile Road, Ferndale 20, Michigan
2600 Cajon Road, San Bernardino, California

XUM

REFINERY PLANTS SCHEDULED FOR COMPLETION

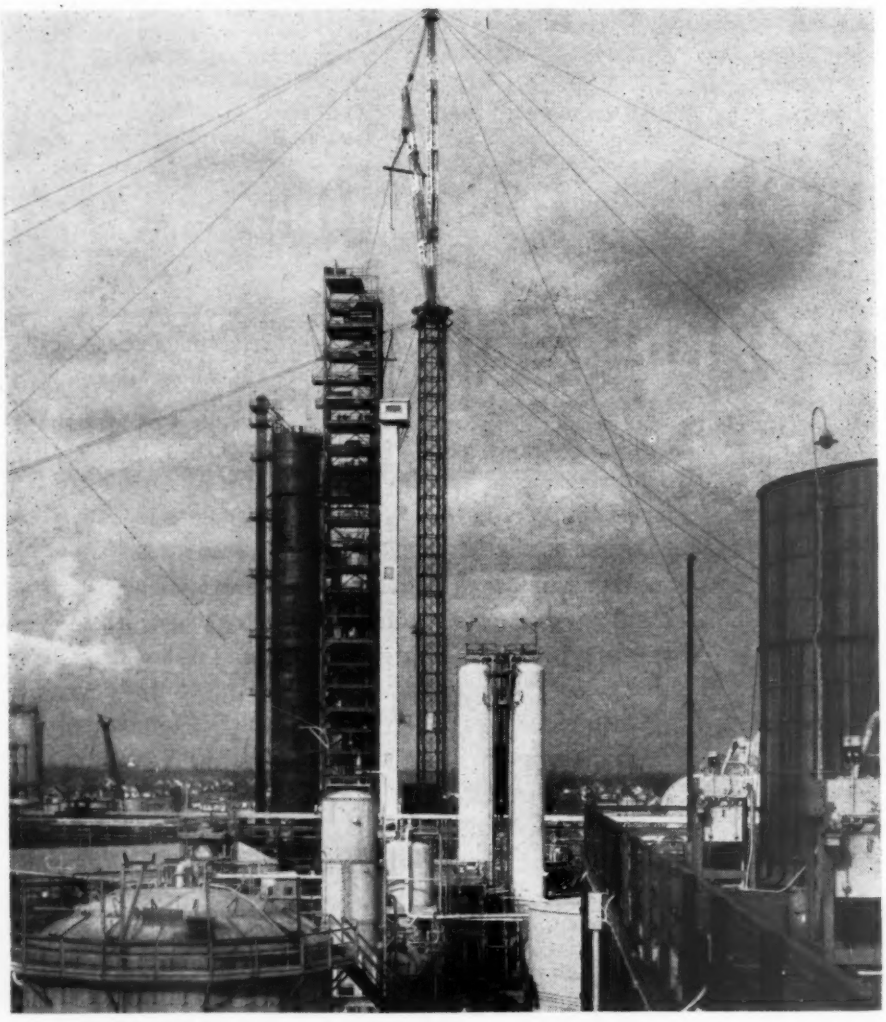
New Cat Reformer. Tide Water Associated Oil Company has placed an ultra-modern oil processing unit on stream at its Avon Flying A Refinery, near San Francisco, California. A hydrobon-platformer, it is a two-unit operation. The first catalytic process removes most of the natural sulfur and other impurities. The second, using a platinum catalyst, rearranges the molecular structure of the liquid passing through it. Hydrogen sulfide gas, a by-product, will be retained for use in making sulfuric acid at an adjacent plant owned jointly by Tide Water and Monsanto Chemical Company.

★ ★ ★

New Ammonia Plant. Contract for building new facilities for manufacturing ammonia and ammonium nitrate solutions has been let by Calumet Nitrogen Products Company to The Fluor Corporation of Los Angeles, California. Plant will be built in Hammond, Indiana. The company is a jointly-owned subsidiary of Standard Oil Company of Indiana and Sinclair Refining Company. Both companies operate large refineries, nearby, at Whiting and at East Chicago, Indiana, respectively. Excess by-product hydrogen from catalytic units at these refineries will be employed in the synthesis of ammonia, combining it with atmospheric nitrogen. Plant will be completed in mid-1956 to manufacture 300 tons per day of products. The moderately high pressure Fluor-Claude process will be used to synthesize the ammonia, from which nitric acid will be produced via oxidation methods.

★ ★ ★

Synthetic Mercaptan Unit. The only unit of its kind in the world, a synthetic mercaptan plant, has been completed recently by Pan American Refining Corporation at Texas City. Methyl mercaptan, CH_3-SH, will be the principal product for the immediate future, with an output of five million pounds. Methyl mercaptan is used principally as a chemical intermediate in the synthesis of methionine, used largely by the poultry industry for adding to feeds to raise the rate of conversion of feed to meat on fowls. The unit is designed so that ethyl and propyl mercaptans, methyl, ethyl and propiv disulfides can be added to the production list as markets for them may be developed.



Two Sun Oil Cat Crackers. Two Houdriflow units are under construction at Sun Oil's Toledo, Ohio, refinery. Outstanding item in these plants is that they are 335 ft high. Catalytic Construction Company is general contractor, Chicago Bridge & Iron is fabricating and erecting the units.

Gulf Coast Expansion. A 100,000 bbl per day crude topping and vacuum unit, and a 68,000 bbl per day fluid cat cracking unit are to be added to the Gulf Oil Corporation refinery at Port Arthur, Texas. Auxiliary units will be a 300,000 lb per hour steam unit, water cooling tower, and new gas treating units for charge to the ethylene units; more amine capacity as a part of the sulfur production system. New units will shut down older refinery units now operating. Work is to start "in the first quarter of 1955, and will be completed within a year." M. K. Kellogg Company will bulid the cat cracker; Arthur G. McKee Company, the crude unit.

★ ★ ★

"Biggest Ultraformer" on Stream." A 21,000 bbl per day Ultraformer, the largest of its process and one of the largest cat reformers in the world, went on stream in late February at the refinery of Pan American Refining Corporation at Texas City, Texas. Normal operations are said to involve 200,000 lb of a platinum-containing catalyst. The product will be used to upgrade Pan American's motor fuel, sold by American Oil Company, of which the former is subsidiary. Catalyst is used in fixed beds that are regenerated at fixed intervals in place.

★ ★ ★

Nitric Acid-Ammonium Nitrate Plant. Ground was broken in early February for Brea Chemicals, Inc., at Paramount, California. The Macco refinery and chemical division is engineering and erecting the plant, which includes product handling and off-site installations.

★ ★ ★

Delayed Coking Unit. Construction of a 7000 bbl per day delayed coking unit has been contracted for by Mid-Continent Petroleum Corporation of Tulsa, Oklahoma, with M. W. Kellogg Company as designers, engineers, and constructors. The unit will be completed later in 1955, it is understood. The charge stock for the unit will be derived as heavy residuum from the 65,000 bbl per day continuous crude distillation units at the refinery. Cost of the unit is understood to be about $2.5 million.

★ ★ ★

New Refinery for Delaware. Selection of a site for a 130,000 bbl per day refinery 15 miles below Wilmington, on the west bank of the Delaware River has been announced by company officials. Ground is to be broken soon, and the plant expected to be operating late in 1956. Site includes 4200 acres. The plant, to cost $100,000,000, will employ 700 persons and will include the largest crude unit in the world, handling 130,000 bbl per day, plus an Orthoflow fluid catalytic cracking unit of 102,000 bbl per day total charge capacity, and a residuum fluid coking unit of 42,000 bbl per day capacity, largest in the world. Other units will include catalytic hydrodesulfurization unit, cat reforming unit, polymerization and alkylation units and a sulfur recovery plant. Seven million barrels of crude and product storage capacity will be included.

FIG. 1. Type B cat cracker has compact layout of fractionator, Orthoflow converter, feed preheater and catalyst storage drums. B-A installed type A at Edmonton refinery in 1951.

Model D cat cracker for B-A on Lake Ontario is a first for fluid design and straightline catalyst flow

ORTHOFLOW UNIT

P 710.1

Raises Canadian Octane Number

J. L. Porter*

THE British American Oil Company Limited's Model "B" Orthoflow fluid catalytic cracker at their Clarkson, Ontario, refinery was placed on stream in June, 1954. The increasing demand for the higher octane gasolines produced by the cat cracker makes it a key refinery unit. Other units at the refinery include two topping and vacuum distillation units, a polyform unit, lubricating oil plant, and compounding and blending and grease plants.

Clarkson is located on the northern shore of Lake Ontario, about twenty miles southwest of Toronto and midway between Toronto and Hamilton. Admittedly the site is one of the finest for a refinery. The ground is level, with a gradual slope toward the lake. The top few feet of soil are clayish, excellent for tank dikes; below that is a strata of shale, making a solid foundation for heavy towers and other equipment. Lake Ontario provides convenient shipping facilities and an ample water supply.

The unit, the first of its kind built in Canada, makes B-A a pioneer in the use of Orthoflow cat crackers. The Orthoflow "A" type built at the Edmonton refinery in 1951 was the first of its type in the world. The Orthoflow cat crackers were engineered and constructed by the Canadian Kellogg Company Limited, subsidiary of The M. W. Kellogg Company of New York.

The Model "B" Orthoflow is one of two versions of Kellogg's exclusively fluid designs for catalytic crackers (Fig. 1). Both designs involve stacked vessel construction with straightline catalyst flow. The principal difference between them is the position of the regenerator which, in the Model "A" is below the reactor and in the Model "B" above it. One advantage obtained with the latter design is reduction in air pressure at which the regenerator operates. Another is a decrease in the size of the reactor and of the fractionator—a result of the higher operating pressure of the reactor. Also, the gas compressor suction pressure is higher and an additional power saving results.

Process Description

The new fluid catalytic cracking unit, together with its accompanying gas recovery and catalytic polymerization equipment has been designed to process 11,610 bbl per stream day of mixed gas oils from the topping and vacuum units which are run on Canada's western crudes with some U.S. crudes. The products obtained from the fluid cracking unit are a 400 F end point, 7.5 lb Rvp debutanized gasoline, light gas oil, decanted oil, catalytic polymer feed, and fuel gas (Fig. 2).

EXCLUSIVE

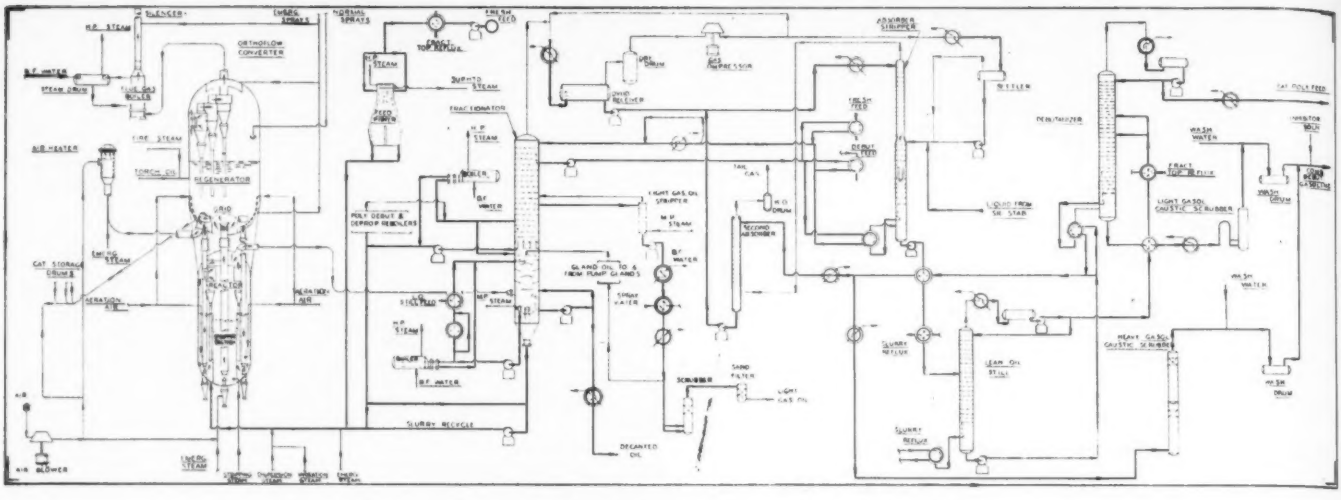
Catalytic Cracking Section

Fresh gas oil charge stock is introduced to the unit from storage. The fresh feed, preheated by exchange with top reflux from the fractionation section and then in a feed preheater furnace, together with recycle gas oil from the fractionator and hot catalyst bearing slurry oil from the fractionator settler, flow to the Orthoflow converter where the cracking reaction and the catalyst regeneration take place. This Orthoflow converter contains reaction, catalyst stripping, regeneration and catalyst circulation facilities.

Powdered natural catalyst is maintained in fluidized beds in the reactor, stripper and regenerator by uplifting vapors and is circulated from one section to another by maintaining different catalyst densities in the catalyst circulation lines to and from the regenerator.

The upper section of the Orthoflow converter is the catalyst regenerator in which coke deposited on the catalyst during cracking is removed by burning. The heat liberated by the combustion of this coke raises the temperature of the catalyst in the regeneration zone. Regenerated catalyst is withdrawn from the regenerator bed through a standpipe and plug valve and is con-

*Head, Process Engineering division, The British American Oil Company, Ltd.



Fluid cracking unit flowchart, Clarkson, Ontario B-A refinery.

FIG. 2. Frightening complexity of modern refinery is simplified by eye-level, labeled recorders and controllers and beautified by spacious and quiet choice of desks and colors in cracker, polymerizer control house.

tacted with oil feed and a small amount of steam in the bottom of the reactor. At this point heat from the catalyst serves to vaporize completely the oil feed and to raise its temperature to that required for the cracking reaction (Fig. 3).

The reaction section of the Orthoflow tower is located directly below the regenerator. The fluidized catalyst bed depth is controlled at the level necessary to provide the contact time with the oil vapor required to obtain the desired conversion. Above the fluidized bed there is a disengaging space for separation of the powdered catalyst from the cracked vapors. The vapors then pass out of the reactor through cyclones which recover the catalyst which has been carried through the disengaging space.

The spent catalyst is withdrawn from the reactor bed to the stripper which is contained in the lower portion of the tower within the reactor. The entrained hydrocarbons are stripped with steam from the spent catalyst and the steam and stripped vapors are vented through the open top of the stripper section into the disengaging space above the reactor bed.

The stripped spent catalyst flows from the bottom of the stripper through a plug valve and into the spent catalyst carrier line which, like the regenerated catalyst standpipe, is a straight line located within the Orthoflow vessel. Sufficient air is introduced through the hollow stem of the plug valve to convey the catalyst upward into the regenerator below the distribution grid.

Air for combustion of coke laid down on the catalyst during the reaction period, is supplied by a motor-driven blower and, except for the amount used to lift the spent catalyst, is delivered to the regenerator through a distribution grid ring. The flue gas from coke combustion passes upward through the disengaging zone for separation of gas and catalyst and then through cyclones to the flue gas boiler where waste heat is recovered in the form of steam. From the boiler the flue gas is vented to atmosphere through a stack. An air heater, which is an integral part of the air inlet line, is used during startup periods to supply the heat necessary to raise the regenerator bed temperature to the level required to start combustion of fuel oil in the regenerator bed, after which the burning of oil raises the bed temperature to its normal operating level.

The rate of catalyst circulation through the system is controlled by the regenerated catalyst plug valve which is regulated to transfer to the reaction zone the amount of hot catalyst necessary to maintain the desired reaction temperature. The spent catalyst plug valve returns the catalyst to the regenerator at the rate required to maintain reactor catalyst holdup.

Two drums are provided for the storage of catalyst. One catalyst drum is large enough to hold the operating catalyst inventory. The other drum is large enough to hold two carloads of fresh catalyst. Fresh catalyst is unloaded from cars by using a steam jet ejector to evacuate partially the fresh catalyst drum. Air flowing through the unloading piping from the car into the evacuated drum carries the catalyst with it as a fluid.

Dry air for aeration, air motor operated valves, instruments and instrument bleeds are supplied by the refinery at 100 psig.

Fractionation and Gas Recovery

Cracked hydrocarbon vapors, steam, and inert gas which entered the reactor with the regenerated catalyst, flow from the reactor to the base of the fractionator tower. Here the vapors are cooled and washed free of catalyst in the scrubbing section. Sufficient cooling is done by the circulation of slurry reflux over baffles and by downflow from the tray above to desuperheat the en-

tering material and to condense the slurry recycle and decanted oil. Heat removed from the tower by the slurry reflux is used for reboiling the gas recovery lean oil still, preheating the lean oil still feed and the generaton of steam in the slurry boiler (Fig. 4).

The tray between the top of the scrubbing section and the heavy gas oil drawoff pan removes any entrained slurry or catalyst that may have been carried up from the baffles below. Above this tray is a total drawoff pan which collects the heavy gas oil which, in turn, is used as reflux for the tower, and as recycle to the reactor. Heat is removed from the reflux stream in the intermediate reflux boiler with steam production and by reboiling the catalytic polymerization unit depropanizer and debutanizer.

A stream of light gas oil product and gland oil is drawn from the tenth tray of the fractionator through the light gas oil stripper. The stripped gas oil is caustic-washed, sand-filtered and sent to storage.

Reflux for the top of the tower is obtained by pumping liquid from the second tray in the fractionator through heat exchangers and back to the top tray of the tower. Heat is removed from this stream by exchange with fresh feed, exchange with the recovery unit debutanizer feed, reboiling the absorber stripper, and finally by a water cooler.

The overhead vapors off the tower are partially condensed, the liquid being sent to the absorber-stripper tower and the vapors to the compressor dry drum. The gas from the drum is compressed by means of a motor-driven centrifugal compressor, then partially condensed and sent to the absorber stripper feed settler. The vapor and liquid from the settler, together with an extraneous liquid stream from the topping unit straight run stabilizer, are fed to the absorber stripper.

Heavy naphtha from the bottom of a clean oil still is used as sponge oil to recover propane and heavier hydrocarbons which escape from the absorber stripper. Tail gas from the secondary absorber overhead flows into the refinery fuel system. Bottoms from the absorber stripper are pumped through heat exchange to the lean oil still (Fig. 5).

The lean oil still is operated to produce a 250 F end point gasoline and lighter material overhead, and a heavy naphtha bottom stream. The net heavy gasoline product is given a two-stage caustic wash, followed by a water wash. The overhead material is pumped to the debutanizer. The bottoms from the debutanizer are the light gasoline product which, when caustic and water washed and combined with the treated heavy gasoline, give the total 7.5 lb Rvp, 400 F end point gasoline product. The overhead product from the debutanizer is pumped through the Girbotol unit for removal of hydrogen sulfide and then to the catalytic polymerization unit. The products from the cat poly unit include a 5 lb Rvp polymer gasoline, LPG, and butane.

FIG. 3. 12,000-bbl catalytic cracker returns a 54.5 per cent gasoline product, 25 per cent light gas oil, 5 per cent decanted oil, 10 per cent cat poly feed and 7 per cent dry gas.

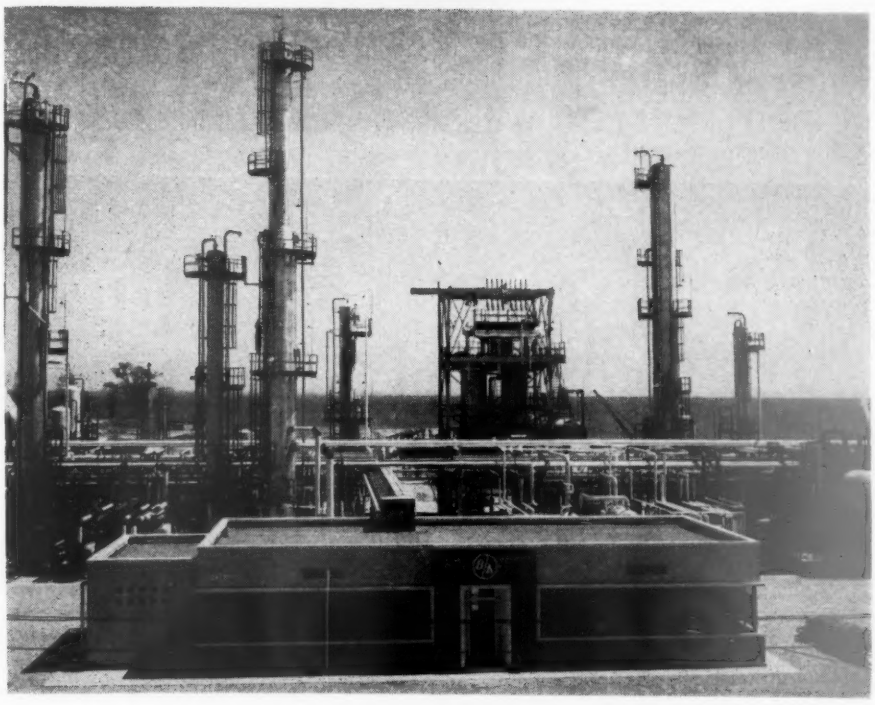


FIG. 4. The straight, simple lines of control house contrasts the convoluted piping of gas recovery units and cat poly towers in background.

Anticipated yield when cracking a 24.7 API gas oil blend, using natural catalyst, 70 per cent conversion, a 1.5 TPR and a reactor bed temperature of 900 F are shown below:

	BPSD	Vol. %
Fresh feed	11,610	100
Combined gasoline	6,324	54.5
Lt. gas oil	2,903	25.0
Decanted oil	581	5.0
Cat. poly feed	1,167	10.1
Dry gas (F.O.E.)	864	7.4
Coke (lb/hr.)	13,500	

An interesting innovation for B-A is the use of induction type electric motor drives on the air blower and gas compressor (Fig. 6). Both electric motors were manufactured in Canada by Canadian General Electric. The 4500 hp motor on the air blower is a three-phase, 4000-volt, 60-cycle squirrel cage induction type motor, with a force-ventilated enclosure, and is the largest motor of its type ever built in Canada by Canadian General Electric. A turbine-driven fan ventilates the motor windings. The blower, a three stage centrifugal machine, is equipped with a 3.1 to 1.0 speed increaser, with a motor speed at 1200 rpm. The 1500-hp electric motor for the gas compressor is also a three-phase 4000-volt, 60-cycle, squirrel cage, induction motor with a force-ventilated enclosure.

Each motor has its own separate ventilating system. Uncontaminated air is drawn from a point about 20 ft above ground level by a steam turbine-driven fan and forced through the motor casing and windings. This ventilat-

FIG. 5. Close-up of new regenerator showing flue gas boiler and vent stack.

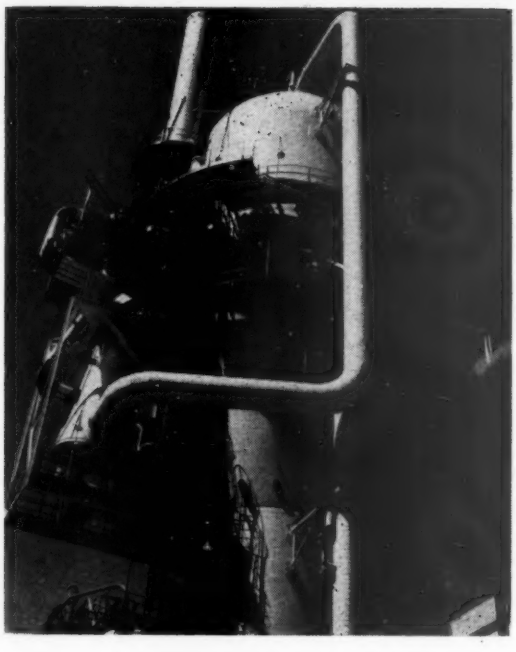
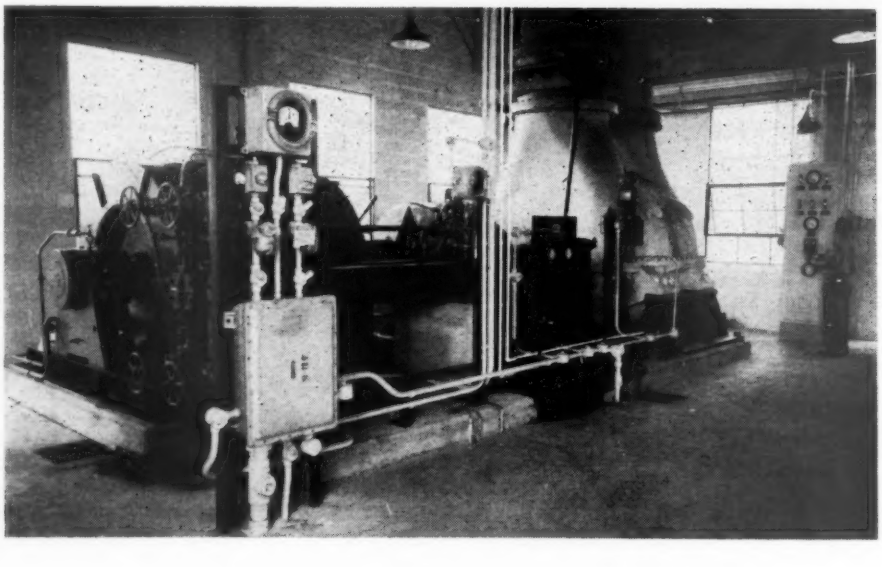


FIG. 6. Canadian engineering features latest developments, as seen in this 3-stage centrifugal air blower driven by 3-phase, 4000-volt, 60-cycle squirrel cage induction type motor.



ing air performs the dual purpose of cooling the motor and pressurizing the motor casing, thus preventing the entrance of combustible vapors.

Each motor has six resistance temperature detector coils embedded in its windings. These six points connect to a strip chart temperature recorder located on the main board in the control room, which continuously records all six temperatures. These temperature points are also tied into the alarm system in the control room and the compressor room. Abnormal temperatures sound a howler in each location and actuate red alarm lights. In the case of the 4500-hp motor, the sixth temperature detector coil connects to a temperature relay in the motor starter. This relay will shut down the motor in the event of dangerously high temperature and will not allow it to be restarted for a period of about 20 minutes, thus giving it time to cool down.

Ventilating air pressure is interlocked with the motor starters in such a way that the motors cannot be started until air pressure has been established in the ducts; the motors are also tripped off the line in the event of air pressure falling below a preset value.

The motor starting equipment, air break type, is located in a building some 300 ft from the motors in an area classified as non-hazardous.

The 1500-hp motor is started across the line. The 4500-hp motor is controlled by a reactor type of starter which provides one step of reduced voltage. The motor starters are interlocked in order that the motors cannot be started simultaneously.

The motors are protected by the following relays:

4500 hp —

Instantaneous overcurrent relays.
Differential relays.
Phase unbalance relays.
Temperature relay actuated by RTD embedded in motor windings.
Time delay undervoltage relay.

1500 hp —

Instantaneous overcurrent relays.
Thermal overload relays.
Phase unbalance relays.
Time delay undervoltage relay.

The switchhouse which houses the starters also contains two banks of capacitors which are connected to or disconnected from the 4160-volt bus as the 4500-hp motor is started or stopped. This switching is accomplished by a separate circuit breaker controlled by auxiliary contacts in the motor starter.

In order to insure continuity of service to this important electric drive, two incoming power lines have been provided for the refinery main sub station. Each line is provided with reclosure breakers timed at 40 cycles in the Hydro Electric Power Commission transformer station. The refinery sub station is equipped with automatic throw-over switchgear which is timed to "ride over" the Hydro Electric Power Commission reclosure time. The 4500-hp motor under-voltage relay has a time setting slightly larger than the throw-over relay, in order that the motor will not trip off during the throw-over period.

The unit is self-sufficient as to steam requirements. The three steam boilers, two on the fractionator and the third on the flue gas stack, produce 55,000 lb per hr of 175 psig steam which is superheated 100 F in the feed preheater furnace. All the steam turbine drivers on the pumps exhaust to 45 psig and this steam is used for catalyst hydration and stripping in the spent cat stripper and fractionator. Since no extra steam generating capacity was added to the refinery boiler house, the steam producing vessels in the catalytic cracking unit have been arranged so that during start-up, steam can be made by circulating gas oil from the feed preheating furnace through the boilers and back to the fractionator.

A new water circulating system was installed for the cat unit. The cooling water discharged from all tubular coolers and condensers passes through a modified API separator. This water is normally free of oil, but an emergency separator is required in the advent of a leaking cooler or condenser. Certain waste waters from reflux drums can be sprayed into the flue gas vent stack for disposal. Other waste waters are carried off-site by a separate sewer.

All relief and overpressure control valves discharge to a smoke controlling flare designed from a similar installation at General Petroleum Corporation at Torrance, California. * * *

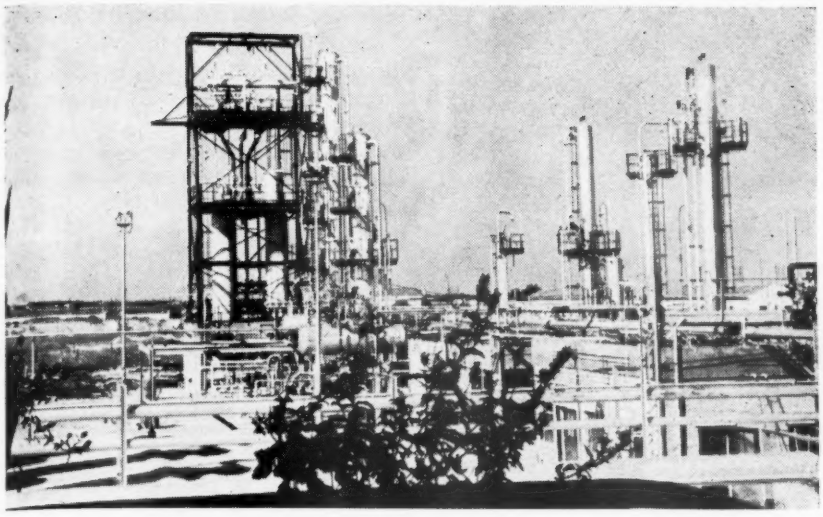
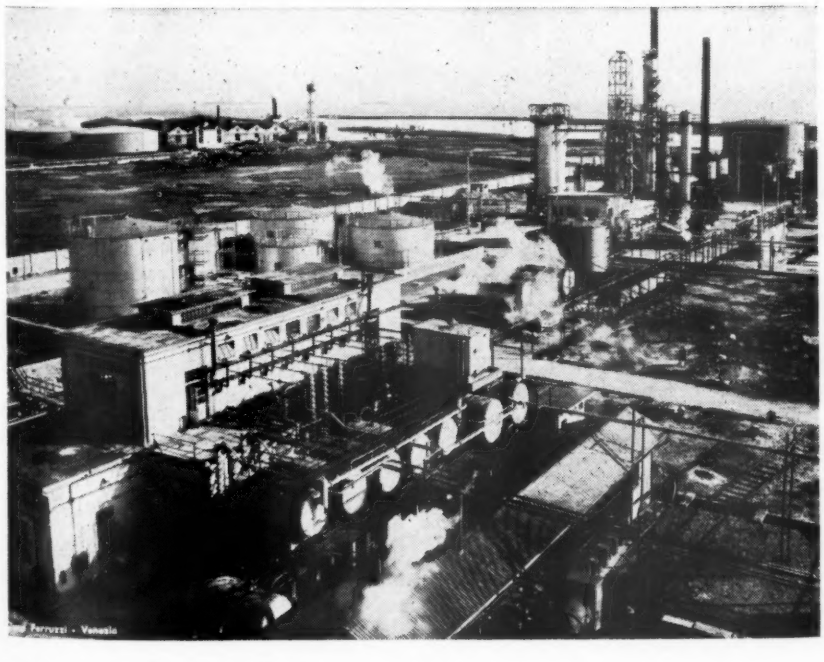


FIG. 1. Kellogg reforming unit at Marghera refinery.

Italian Marghera (Venice) Refinery On Full Stream

V. S. Swaminathan†

FIG. 2. The acid plumbite treating unit at Porto Marghera plant.



LATE in 1948 Industria Raffinazione Oli Minerali (IROM) was formed by Azienda Generale Italiana Petroli (AGIP) and the Anglo-Iranian Oil Company* to step up the crude throughput of the Venice refinery adjoining the village of Mestre, from its nominal capacity of 400,000 tons per annum to 1,000,000 tons a year, and also to process Middle East crude.

The new integrated plant, now in full operation, embraces the following units:

(1) Existing topper, 10,000 bbl per day.

(2) New combination unit, 12,000 bbl per day. (With vacuum section 5600 bbl per day.)

(3) Stabilization plant for PFD.

(4) Existing coking plant, 1200 bbl per day.

(5) New thermal reformer, 6000 bbl per day.

(6) New catalytic polymerization unit, 1300 to 1400 bbl per day charge capacity.

(7) Acid and plumbite treating plants, and

(8) Industrial lubricants plant.

The thermal reformer processes 300,000 tons a year of naphtha to produce high-octane motor fuel component. The refinery accounts for 280,000 tons per annum of motor fuel and the output of high-octane gasoline was further stepped up when the cattalytic polymerization unit to handle the gases from the thermal reformer was commissioned. These two units cater for the demand arising in the Italian market for higher-grade gasoline.

Early in 1952 the original distillation unit, rated 1500 tons per day, was processing 1800 tons daily, and the coking plant was converted to a distillation unit. The new distillation unit is rated 1500 tons per day, but more than this capacity is being squeezed from it. The material for the refinery was 60 per cent U.K., 30 per cent U.S.A. and 10 per cent local (Italian).

Utilities are supplied from the subjoined installations:

(1) Two boiler houses, each having four oil-fired boilers:

(2) Water pumphouse drawing cooling water from the Vittorio Emanuelle Canal through three steam turbine driven pumps delivering to the cooling water distribution system, and

(3) An electrical generator transformer plant. Main electric power comes from the SADE distribution

*Name now changed to British Petroleum Company.

†European correspondent.

EXCLUSIVE

XUM

FIG. 3. Industrial lubricating oil unit, with clay hopper and mixer in foreground.

system, but so far as essential loads are concerned, it is generated inside the refinery by diesel-driven generators.

Electric power is generated in the refinery by two 1000-kw, 50-cycle diesel-driven generators, two 215- kw, 50-cycle diesel-driven generators and one 110-kw, 50-cycle generator. Some power is also supplied by the state-owned electricity authority at 42 cycles and converted to a 50-cycle supply.

The refinery enjoys full facilities for the dispatch of products by ship, barge and rail tank car, and to meet these requirements existing dock and jetty facilities, as well as rail sidings, were added to. The main products of the refinery consist of premium and regular grade gasoline, kerosine, tractor vaporizing oil, gas oil, fuel oil and industrial lubricating oils; the latter, together with bitumens, are marketed through the associated organization ROMSA, whose plant adjoins the refinery site. The rest of the refinery items are marketed through the already available appropriate Italian agencies.

The Venice refinery was originally built in 1919 for processing residue for bitumen production. A decade later, its operation was taken over by another group, which erected a heavy oil cracking and batch redistillation unit. The first major plant installations were set up in the early '30's, when two Dubbs crackers were built, together with a redistillation unit. In 1934 the refinery came under the AGIP. The following year witnessed further expansion, including the erection of a petroleum dock, and the first crude distillation unit. About this time the causeway connecting the mainland to Venice was completed, which markedly improved the commercial status of the refinery. Until 1944 the refinery treated crude oil received in rail tank cars from Rumania. In that year the site was heavily bombed by Allied Air Forces, and the refinery, with other adjacent industrial installations, was largely destroyed. The refinery did duty as a bulk storage depot under the Allied military occupation from May, 1945, until July, 1946, when a certain amount of reconstruction work was undertaken.

The distillation unit and the Dubbs cracker were rehabilitated and brought back on stream in 1947, followed two years later by the second Dubbs cracker, which during the reconstruction period was converted into a reformer.

Plans for the new refinery, calling for additional units, for enhanced capacity, with the requisite specialized units to insure improvement in product quality, and utility plant with particular reference to the supply of power and cooling water were jointly executed by IROM in Italy and the Anglo-Iranian in London. A license was obtained from the Italian government, authorizing refinery operations on Middle East crude oil, and also the eventual manufacture of lube oils.

Orders were then placed in the United States for the design and purchase of the process units, and negotiations were opened with the appropriate local authorities and ECA to procure a dollar loan covering expenditure in America on fees and certain essential materials. A loan of $1.8 million was eventually secured, and contract placed for a 12,000 bbl per day combination atmospheric and vacuum distillation unit. A sterling loan was also obtained from the Italian Government Financial Agency to cover the purchase in the U.K. of a considerable portion of the material and equipment needed for the project.

Designs for the new crude distillation unit were approved during 1949, and buying began both in the United States and Great Britain. At the same time work was started on the development of the layout of the refinery, and the utility needs, so as to integrate the proposed expansion with the existing installation. A contract was placed with CTIP, a firm of specialist engineers in Rome, for all drafting and development work outside the process units.

To provide the necessary components for the production of high grade motor gas, it was then decided to install a thermal reforming plant. Contract for the design and procurement job in the U.S.A. for this undertaking was awarded to a company that had designed similar units for other centers in the AIOC group. Further negotiations were soon started to procure an additional ECA dollar loan, from which payments could be made for the design fees and the purchase of certain specialist equipment for the thermal reforming unit in America.

As work on the project proceeded, it became apparent that in view of the rising trend of motor gas octane level in Italy, the plant already on order would not fully meet the envisaged needs, and it was, therefore, decided to install a catalytic polymerization unit to handle the excess gases from the reformer. This was designed to produce, in addition to the required polymer, liquid butane fractions for sale to a local liquid petroleum gas bottling and distribution company near the refinery, with whom IROM has a supply contract.

To keep in line with the license granted to the refinery, and to meet the present market demands on IROM, it was agreed that the manufacture of industrial lubricants from a wax-free residue would be undertaken by the refinery, and work on the design of acid and clay treating plants for the production of these items has now been completed.

For the accommodation of some of the new plants extra land adjoining the refinery site was purchased, to bring the total refinery area up to 136 acres. Even with this additional area, the site is somewhat restricted, since provision must be made for the eventual installation of complete lubricating oil manufacturing units in the process zone, and, possibly, for additional crude oil reserve storage.

Only the essential minimum tank capacity for finished items is located in the refinery, since it is intended to utilize fully the tankage available in the adjacent distributing depots. The refinery now possesses ample facilities for the dispatch of products by ship, barge and rail tank car. To meet these needs the existing dock and jetty facilities and rail sidings were enlarged. * *

British Petroleum's Arabian Refinery Installs Industry's

FIRST All-Electronic Control Panel

FIG. 1. View of entire all-electronic control panel at Aden plant.

V. S. Swaminathan†

THE past decade has registered remarkable strides in the provision of control facilities for the petroleum, chemical and associated industries. The instrumentation, first of its kind in the world, to control two 60,000 bbl per stream day crude distillation units for the British Petroleum Company's Aden refinery, (on stream last August, four months ahead of schedule) contains several noteworthy features. Each distillation unit is automatically controlled from a desk designed to fit into a bay window overlooking the plant. The process is illustrated by a colored mimic flow diagram with indicators and controller adjustments mounted at appropriate points.

The electrical controllers are arranged as plug-in units and are nested in cubicles in the side wings of the desk to facilitate rapid servicing. Miniature recorders register temperature, flow, pressure, etc. In addition to being recorded, the quantities of various products are totalized by electric integrators mounted on the side wings. Signals from the measuring elements of the plant are transmitted over multicore cables to the control room, where controllers are linked by further cables to electro-pneumatically operated valves on the installation.

Some 40 controllers are used to control each unit, including those for flow, pressure, level, and temperature. Specific gravity transmitters are also provided to indicate in the control room the gravity of various products. Five of the measured values are converted to alarms to give audible warning of any excess deviation. The all-electric graphic panel controls 3 units: Crude distillation installation, a caustic washery and a stabilizer plant. The desks were arranged for shipment in 5 sections, and were provided with quick release terminals to reduce assembly time on the site and to facilitate maintenance.

The all-electric graphic control panel consists of three sections fitting into the bay window and there are two service cubicles, one at each end of the panel assembly. Each of the panel control sections is a self-supporting welded structure fabricated from angles complete with cable trays and removable front access panels with quick release features. To the left of the assembly there are two drawers for the storage of recorder charts and beneath them is the emergency trip valve employed to send all control valves to their "safe" position should an emergency condition arise. The panel face containing the flow diagram is made of medium-hard aluminium sheet and secured to the framework of the panel section by stud bolts. To depict the engraved flow picture at the most comfortable working position for the control room operator the panel face is inclined at 30 deg to the horizontal, with the leading edge 2 ft 9 in. above the control room floor. The width of the panel face is 2 ft 4 in. and the top-most edge is 4 ft 1 in. above the control room floor and 2 ft 4 in. back from the leading edge.

The engraved flow diagram with flow lines ⅛-in. wide and a minimum spacing of ⅝ in. between lines shows all the necessary control valves, flow, pressure, level, and temperature points in their correct location and functional sequence. The sampling points for continuously measuring the pH value of the water draw-off from distillate receivers are indicated. Also, on the diagram are the ammonia injection points for the primary and secondary towers, as well as water injection points upstream of the primary overhead condensers. Miniature indicating controller units 4½ by 3⅜ in. (known as Mini-plaques) and edgewise horizontal O-30mA indicators 2¾ by 1½ in. are also displayed in their correct process location.

Each Mini-plaque has two scales placed one above the other, the upper denoting the measured and desired values, and the lower used for manual control. Transfer from automatic to manual is effected by the employment of a three-position switch located below the lower indicating scale; the third position of the switch being the "service" location. Adjustments to the proportional, derivative, and integral settings are effected by removing the plate which is engraved with the instrument service, and adjusting the settings as required. Full-scale adjustments of the proportional band is 0-600 per cent, derivative from 0 to 10 minutes and integral from 0.2 to 60 minutes. Process equipment such as fired heaters, columns, drums, pumps, heat exchangers, etc., are also fabricated from ¼-in. thick medium-hard

†European correspondent.
*Formerly Anglo-Iranian Oil Company.

EXCLUSIVE

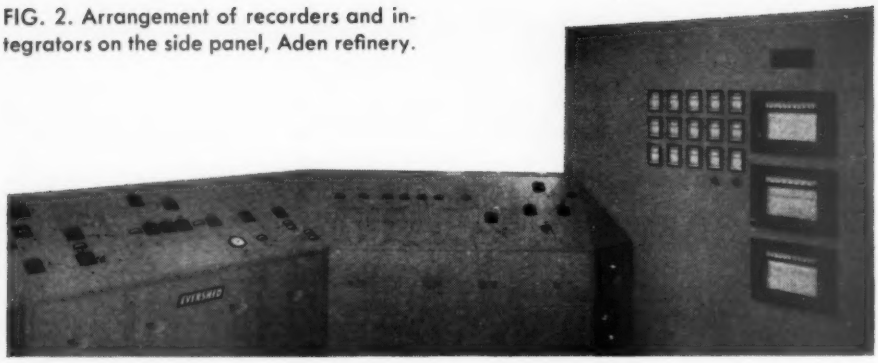


FIG. 2. Arrangement of recorders and integrators on the side panel, Aden refinery.

aluminium sheet and affixed to the panel face. Alarm points like high/low level, high/low pressure, etc., are shown, too, in their correct position.

The annunciator or alarm system has been miniaturized for this installation, and within the confines of the panel proper the circuits are all intrinsically safe. The system, comprising two amber lamps and a change-over switch on the panel, has a circuit which is at rest under normal conditions with both lamps extinguished and alarm horn silent. When an alarm condition occurs both lamps are illuminated and the horn sounds. The control room operator turns the switch beneath the two lamps from normal to alarm which silences the alarm horn and extinguishes one of the lamps. The system is ready, if required, to accept an alarm condition from another section of the plant. The other lamp remaining lit serves as a reminder that an alarm condition on that particular section of the installation is still existing. When conditions have reverted to normal the extinguished lamp relights and the alarm horn sounds, following which the operator returns the switch to normal; the alarm horn is silenced, and both lamps are extinguished.

In the case of forced draft fans on both primary and secondary heaters, flame-proof alarm relays and similar assemblies are located on the locally mounted heater control panel and wired in parallel with the normal alarm system; they thus give visual warning to the heater foreman of abnormal conditions. A test switch is located on the center section of the panel and it tests all circuits of the alarm system.

The control desk is in itself all-electric; the control valves on the plant are actuated by air and positioned by an electro-pneumatic relay. The valve action upon air failure is engraved in the panel face to act as a guide to the control room operator should there be a failure of the instrument air supply or should it be necessary to utilize the emergency trip valve. Temperatures, which are continuously registered by the multi-point electronic recorders situated on the sides of the service cubicles, are depicted on the flow diagram by small discs of ⅜-in. diameter located in the proper flow line, and the temperature point reference engraved thereon.

Other temperatures such as heater flues, heater outlets, reflux lines, and product lines to and from heat exchangers are shown on a flow diagram by small intrinsically safe indicator lamps. These are illuminated when selected by a device which is a new departure in the selection of temperature point indication. This device is used in conjunction with a double-range, continuous balance precision indicator mounted below the face of the graphic panel; and it also includes a switchboard unit, a power unit, and a control panel located on the center section of the graphic panel adjoining the electric clock.

The telephone dial is of a conventional pattern with an additional index hole midway between "1" and the finger stop. For normal temperature logging the dial is used to select the particular thermocouple point required

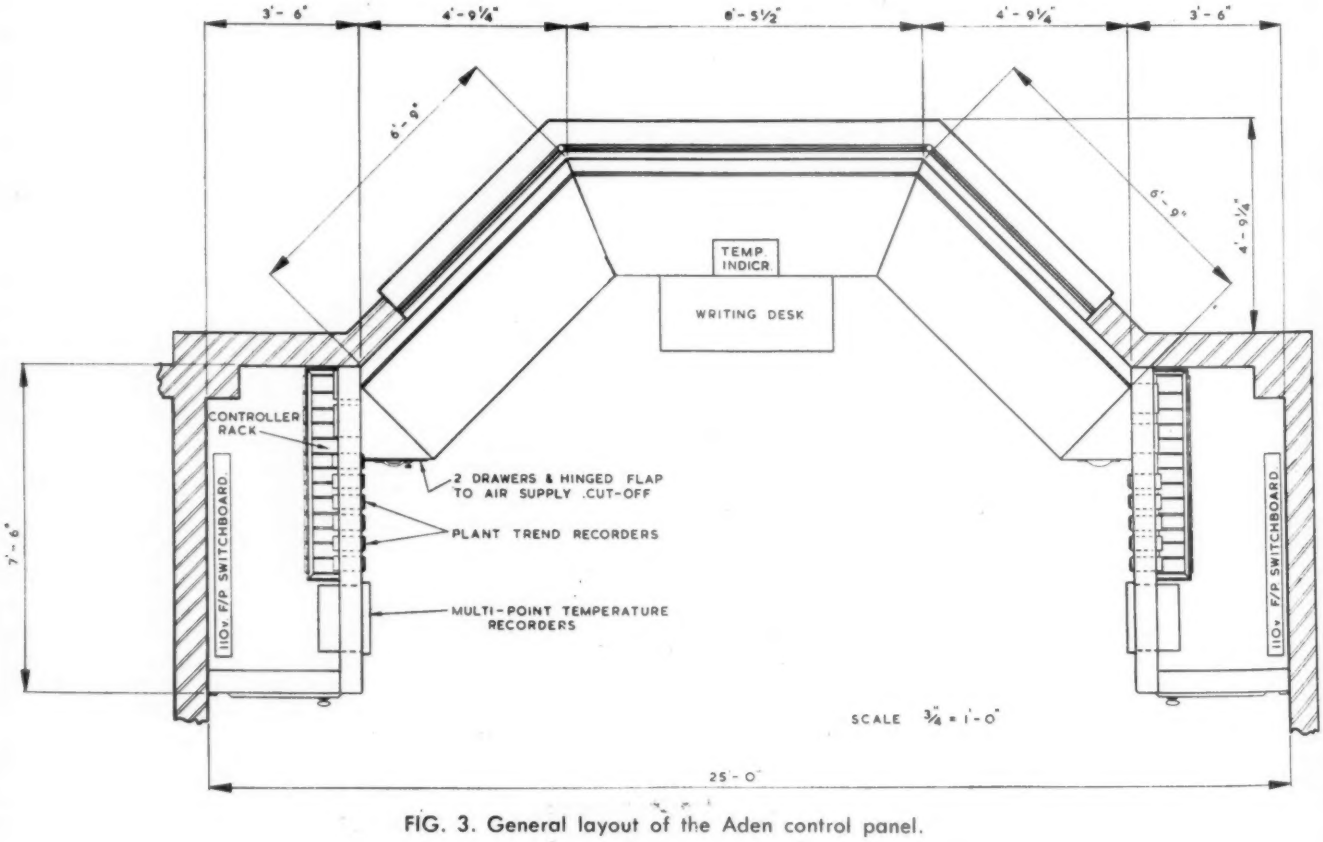


FIG. 3. General layout of the Aden control panel.

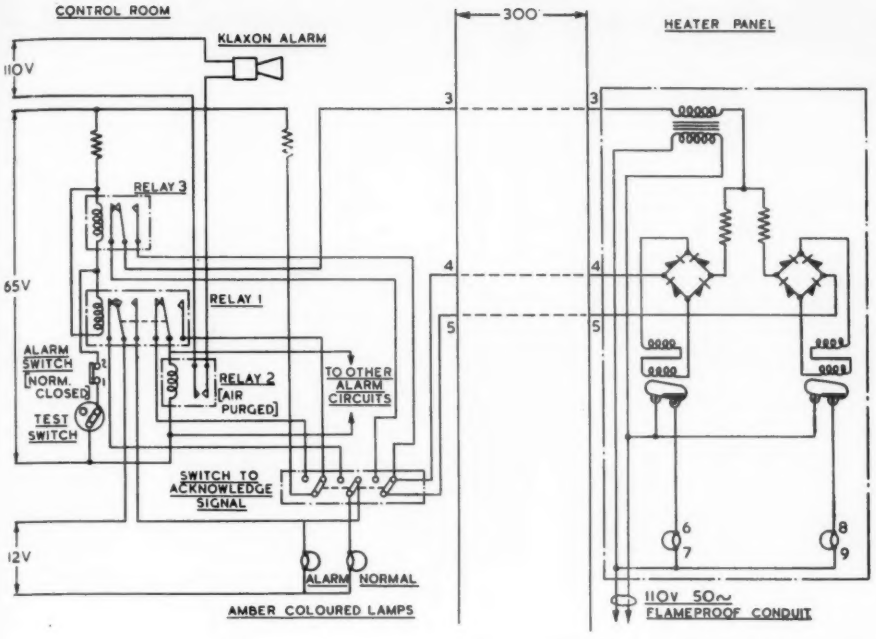
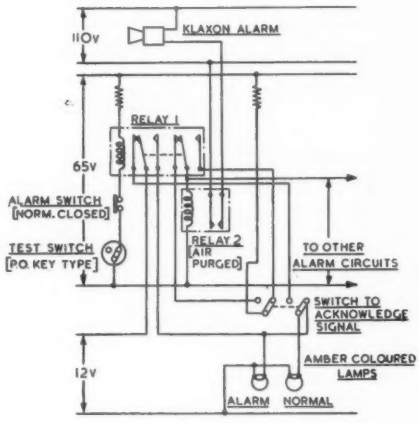


FIG. 4. The normal alarm system, all-electronic control panel.

FIG. 5. The annunciator system wiring diagram.



on the two-digit system; that is, for thermocouple point number 8 it is necessary to dial 08; the two digits being used to select automatically the correct range on the precision indicator in addition to selecting the correct thermocouple line relay. When both digits have been dialed and the dial returns to its "home" position the mechanism performs the following seven functions:

(1) It connects the appropriate thermocouple to the precision temperature indicator.

(2) It gives by means of a cyclometer type revolving numerical indicator a position check to show the number actually selected.

(3) By means of illuminating either the "high" or "low" range lamp it indicates to the operator which of the two indicator scales should be read.

(4) It illuminates a small indicator lamp located on the graphic panel in the position corresponding to the thermocouple location.

(5) It give warning of graphic panel lamp failure.

(6) When selection is complete the extinguishing of the selection period lamp gives clearance for a further selection to be made.

(7) When clearance under (6) is received the selected couple is held connected to the indicator for an adjustable period between 10-40 seconds "duration hold," after which the system automatically clears itself. The full-scale travel of the indicator is 15 seconds.

In the event of the control room operator wishing to scan several points in rapid succession, it is possible to select and note a thermocouple reading every 3½ to 4 seconds, which is the minimum time required for selection and clearance. The temperature interval between the points selected actually determines the rate of scanning as it is necessary for the indicator to come to balance. To cancel the previous selection during rapid scanning, use is made of the extra index hole, thus converting the system from a two- to a three-digit system giving immediate clearance and re-selection without waiting for cancellation by the normal duration hold mechanism. If for any reason the dialing operation should be interrupted and left uncompleted the system is so arranged to clear itself automatically after three seconds.

The switchboard, housed below the right hand section of the graphic panel, houses the relays, fuses and terminal boards. It is air-purged and mounted astride a service trench which is used to bring the thermocouples to the terminal boards. The latter have capacity of 99 thermocouples some of which are optional indicating/recording points. In the case of the optional points the normal operating condition is for the temperature to be recorded but at any time the temperature may be measured by the precision indicator without interruption of the record.

Six 18-core color-coded cables are used to connect the indicator lamps with the switchboard, the lamps being wired to a common return. A six-core cable connects the precision indicator with the control unit, and between the precision indicator and the switchboard there are two connections, both compensating leads, one of iron-constantan and one of chromel-alumel.

Within the switchboard there is an adjustable relay for the duration hold and also adjustments for the position check indicator. Fuse failure is indicated by a standard dropper indicator built into the switchboard, and this is available for transmission to an audible warning system if required. The switchboard is fed with 50 volts dc from an air-purged power unit which has ±2½ per cent trappings incorporated in the output stage, and each compartment in the switchboard is fitted with an interlock switch. Provision is made for maintenance servicing by the installation of a master switch housed in the switchboard which when operated cuts out the interlock switches and provides power to the selector and relay mechanisms and allows the maintenance staff to adjust contact loadings under operating conditions—an essential requirement for this type of equipment.

In addition to the six multi-point temperature recorders on the sides of the service cubicles, there are 33 single-point plant-trend recorders, 3 of which have selector switches; 2 being capable of switching in up to 5 separate signals. The third has a 2-position selector switch and is used to record the pH trend of the water draw-off from either the primary distillate receiver or the secondary one. The ammonia injection points are manually controlled, control being based on information furnished by the recorder. This recorder differs from the remainder in requiring only 600-1300A for full-scale travel of 6-13 pH, whereas 0-30 mA is required for the other recorders, which, however, are capable of suppressed range operation where necssary.

A total of ten cyclometer-style electrically operated integrators are installed, five per side, to give an advancing total of process quantities. One integrator gives the total crude charge to the unit and eight of the remaining give the progressive quantities of end

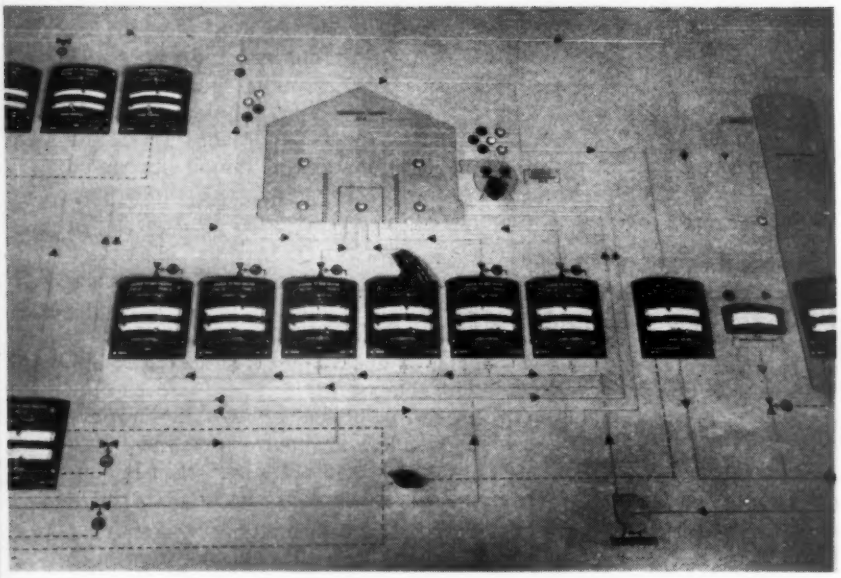
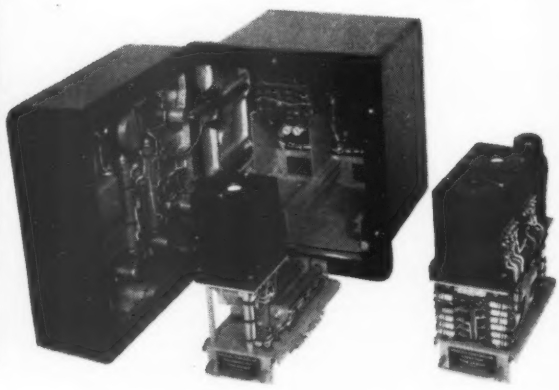


FIG. 6. Closeup of a group of controller adjustments, (Mini-plaques).

FIG. 7. The all-electronic controller, with trays removed, showing a measuring tray in front, and a three term tray at right.



products. The ninth integrator is for a possible alternative service on the stabilizer unit.

Four products, namely naphtha, benzine, kerosine, and stabilized gasoline, after passing through the caustic washery, are measured for their specific gravity. Light and heavy gas oils are also measured for specific gravity before leaving the unit on the way to storage facilities. All these measurements are presented on the panel face by "suppressed" range edgewise horizontal indicators. The full scale span of the indicators covers a change of specific gravity of 0.07 which corresponds to an output of from 10 mA to 20 mA from the field-mounted transmitter which in itself has an output of 0 to 30 mA for a specific gravity change of 0.21. The middle third of the indicator scale has a vertical red line at the beginning and at the end and these serve as a guide to the control room operator as to the lower and upper limits of "on spec" products. At any time the specific gravity of any product may comfortably be read to three significant figures.

All the measuring and control units are housed within the service cubicles, the majority being mounted in two-tier racks, one rack, per service cubicle. Each rack is 4 ft 10 in. long by 1 ft 5 in. deep by 2 ft 9 in. high, and is bolted to the floor inside the service cubicle as well as to the rear of the service cubicle panel. A service trench runs beneath the panel sections and into each cubicle the control cables from the instruments drop from the panel cable tray and feed to their respective control trays.

In the two racks there is a total of 55 measuring trays—5 "proportional" trays, 31 three-term trays, 2 trays for hand-control supply units, 2 complete spare controller trays, 5 spare measuring trays, 6 temperature transmitter power units, and 1 alarm system power unit. The top of each rack is fitted with terminal blocks all of which are clearly tagged with the instrument number, and all the six-core cables from the instruments on the panel are brought to one side of the terminal block and the cables from the control and measuring trays to the other side, both sets of cables being to a common color code. The connection of the trays to the wiring system is by means of a 12-contact plug and socket. A microswitch is wired in series with the power supply and so adjusted to break it before plug and socket separate. In addition, on each measuring tray a neon stabilizer tube gives visual indication of whether the power is on. The tray assemblies are housed in separate compartments, which are capable of accommodating one measuring tray and one three-term tray, or three measuring trays. These compartments are sealed and purged with air.

The 110 v power leads to the controllers are run inside the copper tubes which bring air into the compartments; additional air is fed in by means of a manifold frame which is also used to provide a support for the tray compartments. Each compartment is fully tagged with its particular function by means of a transfer on the exterior of the case. In order to distribute the 110 v supply to the various other power-operated equipment within the service cubicles, use is made of two air-purged distribution boxes per cubicle with the power leads run in copper air tubes.

The incoming cables from the field-mounted transmitters are brought into a terminal block located inside the cubicle at the top of the panel where the individual terminals of the blocks are identified by letters and instrument tag numbers, as well as by the color coding of the cables to and from the measuring controller racks. This color coding, being consistent throughout the entire installation, greatly assists in easier maintenance and the cutting of time required to replace any faulty equipment. Replacement mini-plaques and edgewise indicators are supplied with sufficient six-core color coded cable permanently attached to enable their installation in any part of the graphic diagram and still be connected to the controller rack.

The background of the graphic section of the panel is matt finish sea green, all process equipment is finished matt aircraft gray and all flow lines are colored in accordance with the following table, all finishes being matt: Hydrocarbons, traffic yellow; steam, traffic red; water, traffic blue; chemicals, leaf brown.

All flow arrows, control valves, including identification discs and "air failure-valve action" symbols, and temperature recorded points are finished matt black. The bezels of the instruments located in the graphic section and those in the side panels are finished in Brunswick green. Where equipment names and service are engraved upon the silhouette, the engraving is filled in black, but the engraving on the instrument bezels is white filled. All other name plates are made from Perspex engraved in reverse with black fill and fixed to the panel by means of aluminium rivets having sea green colored heads. The supporting structures and side panels are finished in matt dove gray.

Engineering for the process control equipment was by E. B. Badger and Sons, Ltd., and installation was by the Bechtel-Wimpey organization. * * *

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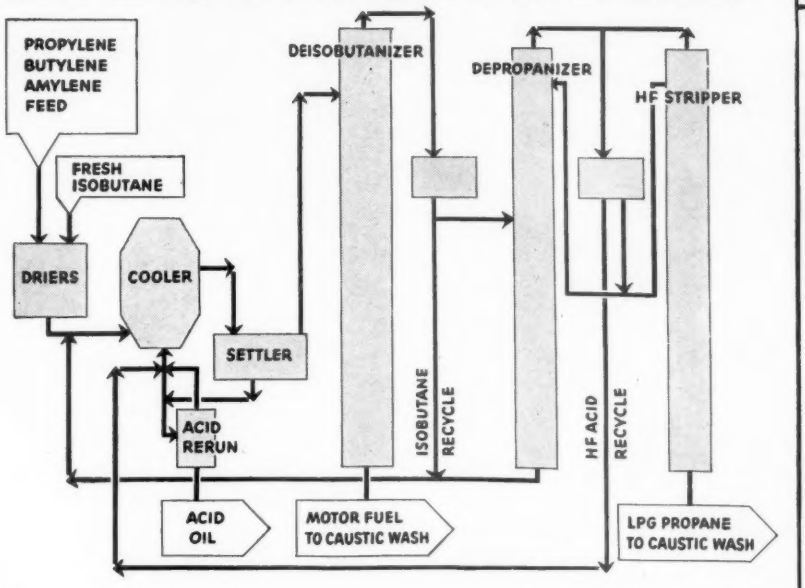

Liquid feed, containing olefins and isobutane, is passed through driers and fed into a cooler along with liquid recycle hydrofluoric acid. Hydrocarbons and recycle acid then flow to the settler. The acid phase is recycled to the cooler. The hydrocarbon phase is fractionated to separate high octane motor fuel alkylate from recycle isobutane.

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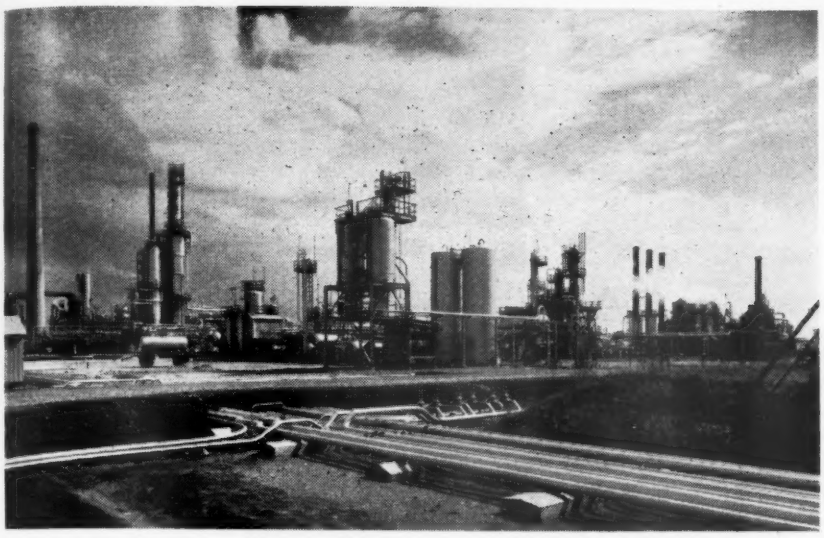
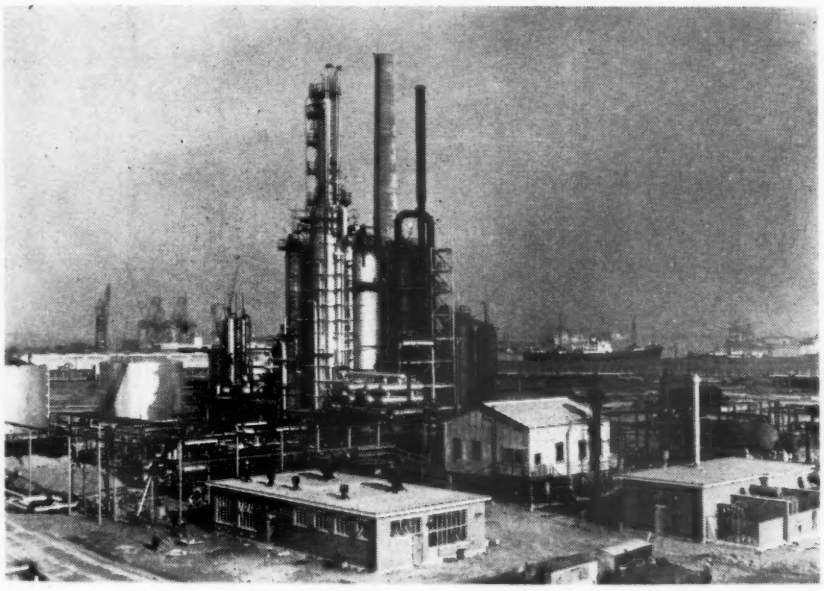


FIG. 1. General view of the Esso Antwerp refinery.

FIG. 2. Combination distillation unit, "backbone" of the Esso Antwerp plant.



Antwerp Refinery Completely MODERNIZED

EXCLUSIVE

THE latest in fluid catalytic crackers and SO_2 treatment plants, together with a combination unit, are featured in the new Antwerp, Belgium, refinery of Esso Standard Refinery, S.A. Designed to process Aramco crudes for prime fuel products and light and heavy fuel oils it was engineered by the Standard Development Corporation and constructed by Lummus. Its capacity is 27,000 bbl per day.

The refinery has been designed on the basis of the new simplified processing technique recently developed by Standard Oil Development. Instead of the usual two-stage pipe still, a heavy naphtha reforming unit, a fluid catalytic cracking unit, gas compression facilities, and a naphtha stabilizer, as well as miscellaneous blending and treating facilities, the combination unit, through the use of the new technique and by combining and integrating processes, eliminates many major equipment items required in the more conventional processing sequence.

In addition to this simplification and the incorporation of a Model IV fluid catalytic cracking unit, other major cost reductions have been effected. The concentration of the smaller number of major equipment items in a single block requires a minimum number of utility and process tie-ins. Refinery losses are reduced, as processing steps are fewer and many sewers and roads are completely eliminated or greatly simplified.

Again, because of plant's compactness fewer operating personnel are needed. The cost reduction and improved operation are said to outweigh the reduction in flexibility inherent in a highly integrated unit.

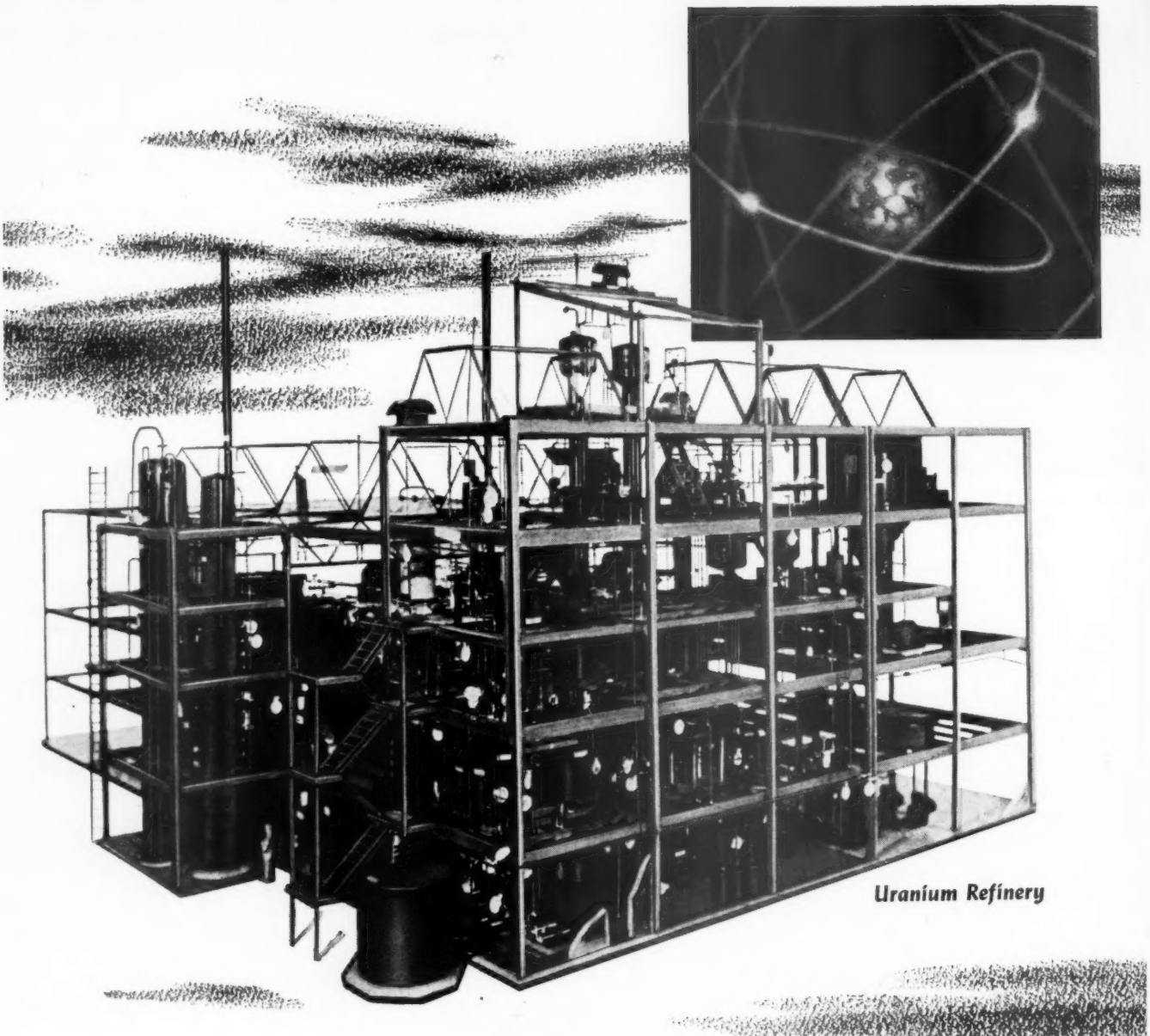
The simple flow plan shown illustrates the process sequence. Plant's operations are as follows:

Crude Distillation

Crude oil is fractionated in a pipe still to make a light naph.ha overhead, three sidestreams, and a reduced crude bottom stream. This equipment has been designed to operate on three alternate operations with the No. 2 sidestream producing either kerosine, light diesel oil or jet fuel.

Crude from tankage, after being heated by exchange and the cabin-type crude heater, flows to the flash zone of the pipe still tower. The overhead light naphtha is pumped to the depropanizer and is stabilized. The depropanizer vapors are processed in the absorber for recovery of gasoline fractions and the depropanized virgin naphtha bot-

*European correspondent.



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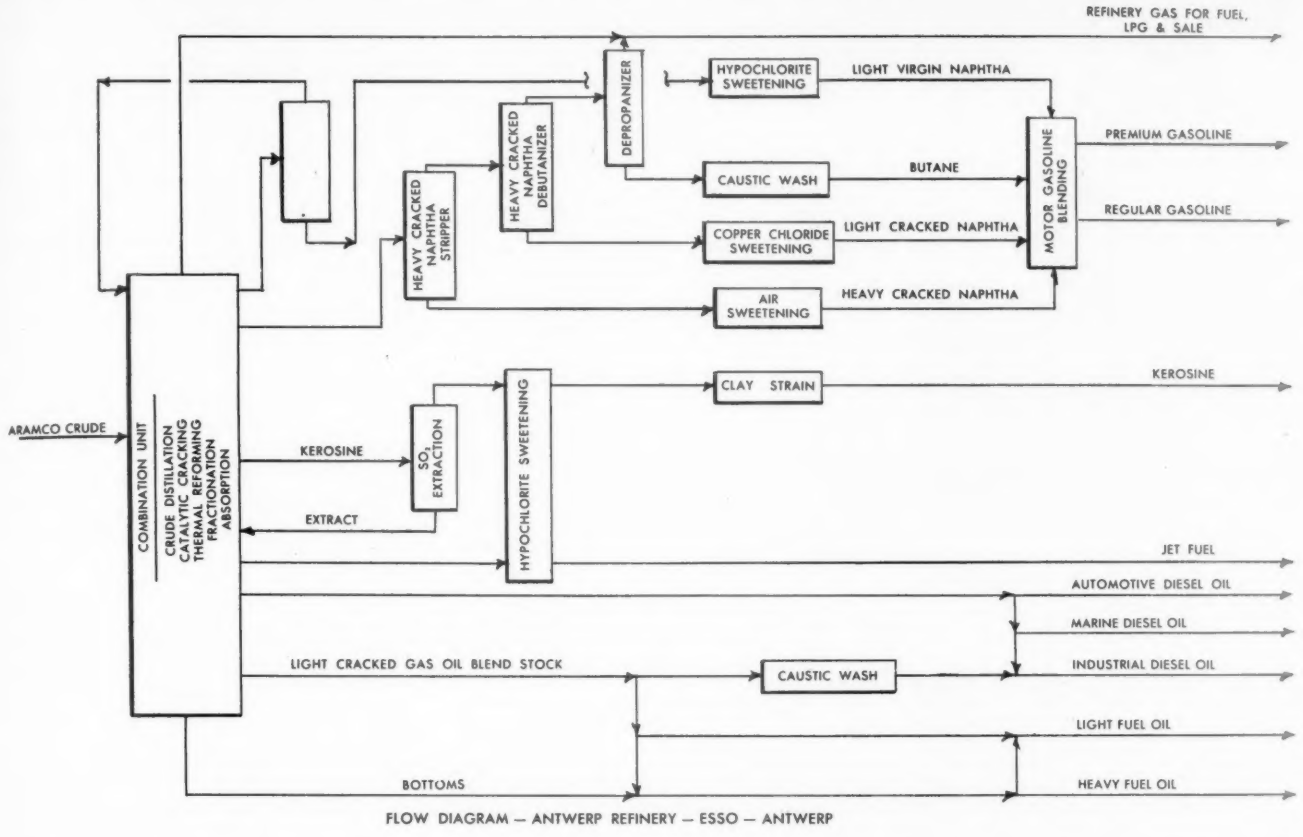


FLOW DIAGRAM — ANTWERP REFINERY — ESSO — ANTWERP

toms are pressured through a cooler to the sweetening unit.

Heavy naphtha is withdrawn at the first side stream and is sent to the reformer furnace. During kerosine operation the No. 2 sidestream flows to the SO_2 extraction unit feed tanks. For diesel operation this side stream is sent to the light diesel oil blend tanks. In the jet fuel operation the product goes to the hypochlorite sweetening unit.

The third side stream withdrawn as a total drawoff is split into a reflux and a product stream. A portion of this product is diverted to the catalytic cracking unit as feed stock and the rest is line-blended with the light diesel oil from tankage for the production of marine, automotive, and industrial diesel fuels. The pipe still bottoms are steam stripped in the lower section of the tower.

Naphtha Reforming

The naphtha reforming furnace is designed to process heavy naphtha. The reformer product vapors leave the coil outlet at 755 psig and 1105 F and are discharged into the flash zone of a fractionating tower through a hand controlled release valve.

Catalytic Cracking

The Model IV fluid catalytic cracking unit is a completely new type of unit. The novel features include a catalyst circulation system that operates without slide valves, has a much lower height, a greatly simplified catalyst recovery system, and uses smaller vessels.

Reduction in investment cost in the order of 20 per cent and a corresponding lowering of operating costs are claimed. Along with the reduced costs the simplified Model IV unit provides reduced maintenance and easier control with attendant reduced labor requirements. Also, it is said, decreased catalyst attrition and further improvement in the wide flexibility of yields, conversions, operating temperatures, and catalyst circulation rates inherent in fluid catalyst cracking units, are accomplished in the Model IV unit.

The feed to the unit consists of a mixture of fresh and recycled gas oil. The unit will produce high octane gasoline blending stock and diesel oil and light and heavy fuel oil components as well as fuel gas. Hot feed at a preheat temperature of 600 F is injected into the reactor inlet line where it is vaporized by mixing with a stream of hot catalyst from the regenerator. This mixture flows into the dense phase where the cracking reaction is completed. The reactor products leave the dense bed, are disengaged from the catalyst, and pass through the reactor cyclones for further catalyst removal. The catalyst is returned to the dense bed and relatively catalyst-free vapors are sent to the flash zone of fractionator.

Spent catalyst is withdrawn from the reactor through the baffled internal steam stripper and flows to the regenerator through the spent catalyst U-bend and dense-phase riser. The catalyst is reactivated in the regenerator by burning off the carbon laid down during the cracking process. Combustion air is supplied by the primary air stream introduced through the auxiliary burner and by the dense-phase riser air. This latter stream also controls the rate of catalyst withdrawal from the reactor to the regenerator. Total regeneration air amounts to 13,700 scfm and is supplied by a motor driven centrifugal blower. The catalyst is recirculated to the reactor through the regenerated catalyst U-bend and the oil injector.

Flue gases from the regenerator are disengaged from the dense bed and pass through cyclones to recover most of the entrained catalyst. Some of the heat in the hot flue gases is recovered before being released to atmosphere.

Anticipated catalyst loss from the unit will be low, it is said, despite the fact that neither precipitator nor slurry settler is provided.

XUM

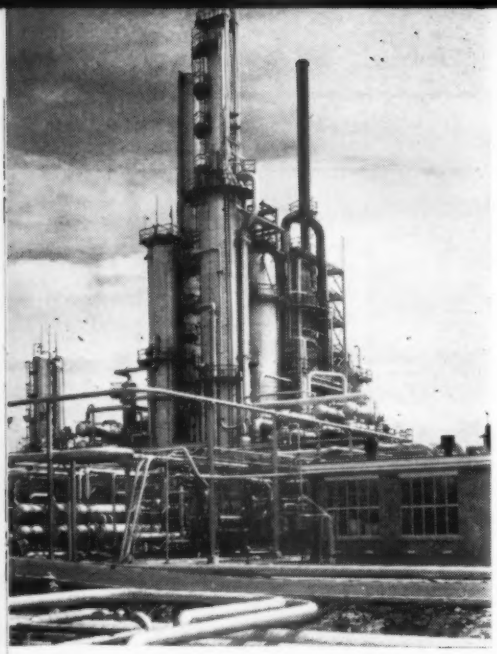
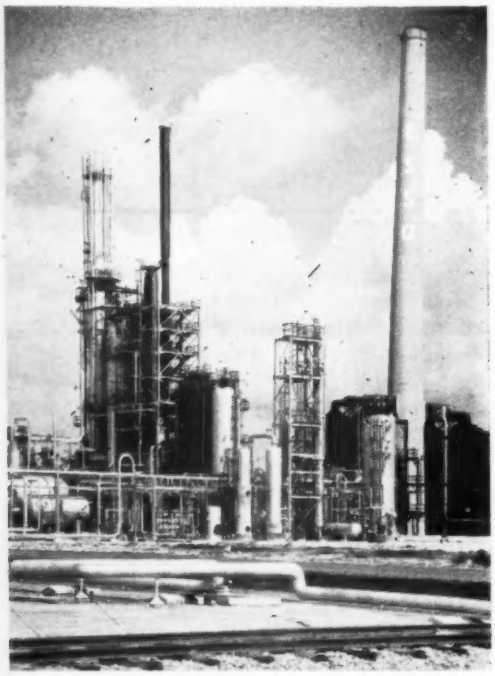


FIG. 3. a and b. Views of combination unit from opposite sides.



Fractionation and Absorption

The fractionation and absorption sections of the combination unit process the unit streams from the reformer furnace and the catalytic unit reactor together with the overhead vapors from the light virgin naphtha stripper. Product streams of these operations include a heavy bottom stream, light cracked gas oil blend stock, a mixed naphtha stream, and dry gas. The bottoms is line-blended with light cracked gas oil to light fuel oil specifications. This heavy fuel oil is pumped to product tankage with a portion being diverted for blending with additional light cracked gas oil to lighter fuel oil specifications. The remainder of the light cracked gas oil is caustic-and water washed and then blended into the industrial diesel oil product. The dry gas stream is pressured to the refinery fuel gas system.

Light Ends Recovery

The mixed naphtha stream from the combination unit fractionation section is pumped through heat exchange into the stripper. The stripped heavy naphtha is withdrawn from the bottom of the tower, cooled, and pressured to air sweetening for finishing. The overhead vapors from the stripper are partly condensed and fed to the debutanizer. The stabilizer light naphtha flows from the debutanizer's reboiler through a cooler to the copper chloride sweetening unit. A stream withdrawn from the debutanizer is pumped to the top of the stripper as reflux.

Overhead vapors from the debutanizer are totally condensed. Part of this stream is pumped to the debutanizer tower top as reflux and the rest is fed to the depropanizer tower. The depropanizer bottoms are cooled and sent to the condensed caustic wash facilities at the sweetening unit. The overhead vapors are partially condensed with the liquid pumped back as reflux to the top of the tower and the uncondensed vapor is discarded to the refinery fuel gas system.

Product Finishing

Two hypochlorite sweetening units are provided, one to process light virgin naphtha and the other to finish, in a blocked operation, either kerosine raffinate or jet fuel. Hypochlorite sweetening is employed to oxidize the mercaptan type of sulfur compounds to disulfides, which are not objectionable from an odor standpoint. Undesirable reactions between the hydrocarbons and hypochlorite are minimized by using low hypochlorite and high caustic concentrations, short treating times, and treating temperatures of 100 F or lower.

Sweetened products are water-washed to remove entrained sweetening solution, settled, and pumped to tankage. To assure a bright kerosine product the water wash is followed by sand filtration to remove entrained water. The kerosine then passes through a clay finishing tower for odor, color and wick char improvement and final water haze removal. Finished jet fuel is given long time storage for final water haze removal.

The light cracked naphtha copper chloride sweetening unit employs the conventional Linde process. The raw naphtha from the debutanizer is caustic-and water-washed to remove hydrogen sulfide. It is then sweetened by contacting with a clay copper slurry in the presence of oxygen. After water washing and drying the finished naphtha is sent to storage. As gum formation in cracked stocks is accelerated by the presence of some copper compounds, a metal deactivator is added to the sweetened naphtha before tankage.

Facilities for air sweetening the heavy cracked naphtha have been provided. This process removes aromatic mercaptan, residual hydrogen sulfide,

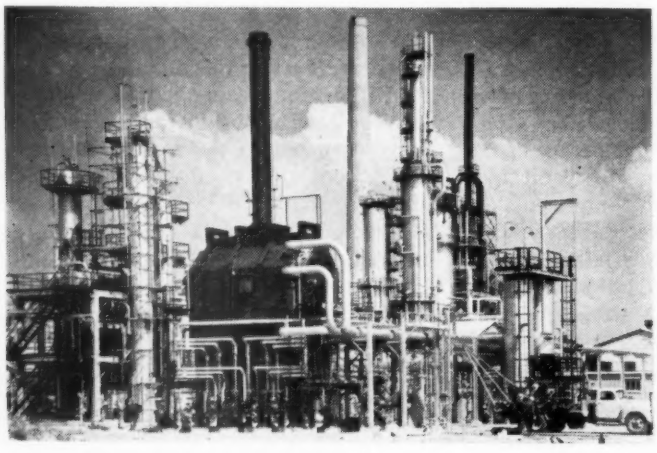


FIG. 4. Close-up of a treating unit.

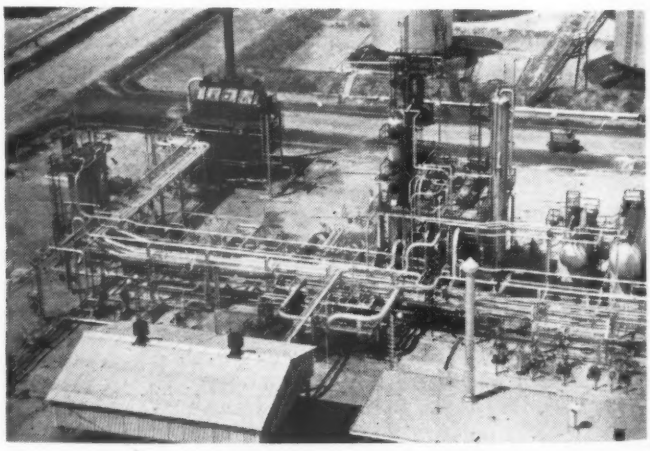
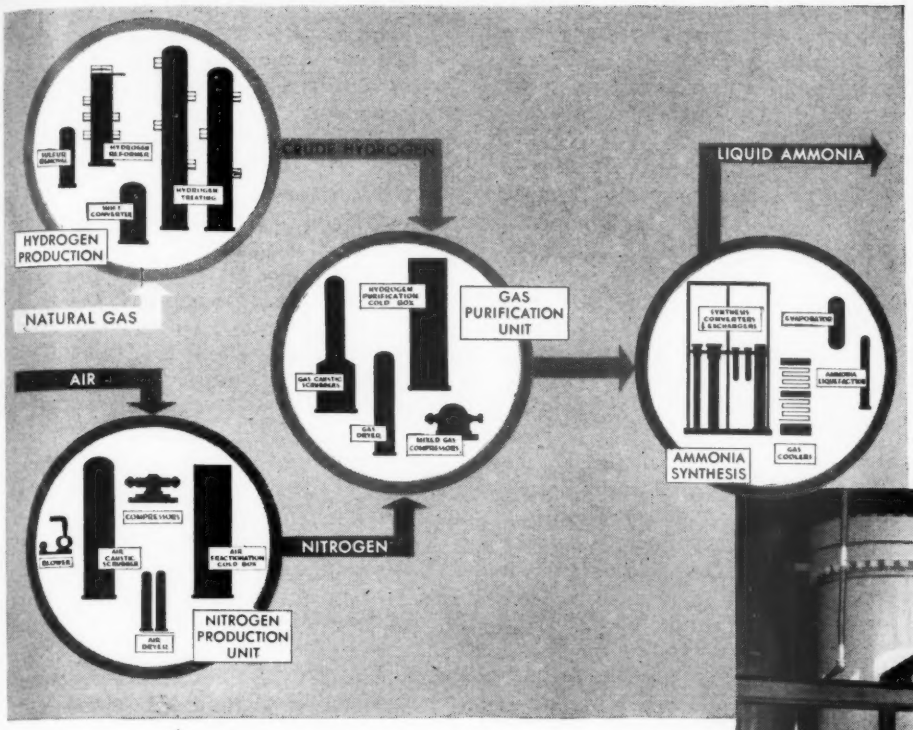
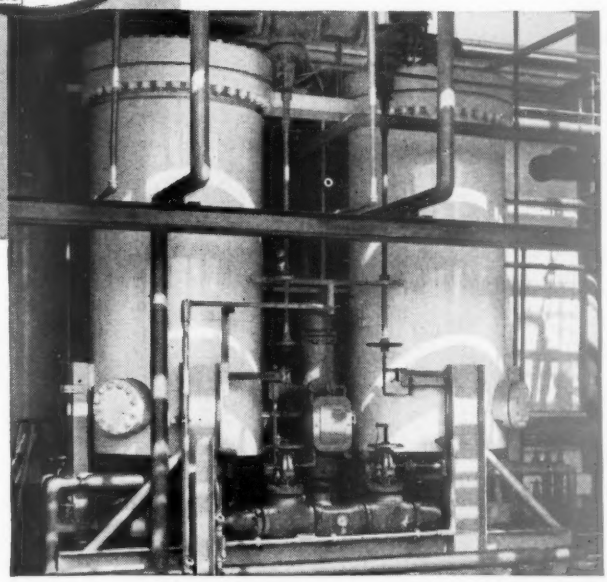


FIG. 5. Details of the piping system of a sweetening unit.



Air and natural gas are synthesized to form liquid ammonia, as indicated by this Brea Chemicals flow-chart. Two Lectrodryers like that below dry incoming air to a moisture content of 1/10,000 per cent, or lower.



How LECTRODRYERS prevent process freeze-outs at BREA CHEMICALS, Inc.

A freeze-out occurs when moisture-laden air or other wet gas enters a heat exchanger to be liquefied. As the air chills, the moisture condenses, freezes and forms rime ice. With a Lectrodryer* in the process, freeze-outs are prevented without interrupting production.

Brea Chemicals keeps this liquid ammonia process humming with two giant Lectrodryers drying all incoming air to a moisture content of one part in a million. So little moisture gets by that de-icing is required only two or three times per year.

If moisture is your problem, regardless of the process involved, a Lectrodryer is the solution. Lectrodryers provide dehumidification or dryness according to the specific need, even to dewpoints as low as –100° F. Lectrodryers are built to handle pressures as high as 6000 psi. They may be automatic or manually controlled.

Write for *Because Moisture Isn't Pink,* which describes industry's use of Lectrodryers. Request engineering information. Pittsburgh Lectrodryer Corporation, 303 32nd Street, Pittsburgh 30, Pennsylvania.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

* REGISTERED TRADEMARK U.S. PAT. OFF.

phenols and cresols, and a portion of the aliphatic mercaptans. Caustic and water-washed heavy naphtha from stripper is contacted with dry air and sent to storage. The naphtha remains in tankage for a minimum of two days to complete the sweetening process.

The SO_2 extraction plant treats the raw virgin kerosine distillate with liquid sulfur dioxide to produce finished kerosine suitable for lighting. The primary function of the SO_2 treating is to extract the aromatic hydrocarbons, which affect adversely the smoke point of lighting kerosine. Other effects of the treatment are reduction of sulfur and wick char.

Dried cold feed is contacted countercurrently with cold liquid SO_2. Two phases are formed, an upper raffinate phase containing paraffinic hydrocarbons and a lower extract phase of high aromatic content. The raffinate is stripped of solvent in an SO_2 recovery unit, caustic-washed, and pumped to the hypochlorite sweetening unit for further processing. The extract is similarly rendered SO_2-free and then fed to the combination unit for re-running.

Offsites

The gasoline blending facilities are designed to line-blend premium and regular grade motor gasolines. Blending stocks consist of light virgin naphtha, light and heavy cracked naphtha, and butane. After blending the unit finishes the products by continuous injection of sufficient additives to pass the gum, stability, color, and octane specifications.

The design of the blending equipment is based on operating for one 8-hour shift per day of seven days per week. Blending will be performed on a 10-day cycle, requiring three days for premium and seven days for regular gasoline.

Facilities have been provided to minimize air and water pollution. A deodorizer will remove the odorous compounds present in all caustic streams and in the hydrogen sulfide-bearing water from the various distillate drums. A ground flare sized to handle the maximum gas make of 12,600,000 std cu ft per stream day has been provided. A water spray reduces the flame size and luminosity and minimizes the smoke. The refinery separator provides the facilities for the separation of oil and water from the clean and dirty water system.

The electrical power used is purchased from the City of Antwerp and is supplied at 15,550-volts to the refinery substation.

The refinery's steam requirements are supplied from three 30,000-lb-per-hr boilers operating at a nominal pressure of 150 psig and 450 F total temperature at superheater outlet. Boilers are of the multiple drum, water tube-type with water-cooled furnace walls and floor.

Weathertight steel casings for outdoor installations have been provided and an elevated platform provides a common firing aisle that connects with the boiler control room.

Feed water is taken from treated storage tank through the blowdown feed water exchanger and deaerating heater to the boilers. The water treatment system consists of two sodium zeolite softening units and a brine tank for zeolite regeneration.

The cooling water main pumping station takes suction from the main basin. Two 10,500-gpm motor-driven vertical centrifugal pumps are used. In addition, two 2000-gpm fire pumps have been installed. One of these is motor driven and other gasoline engine powered.

The plant is completely protected by fire-fighting facilities. A mobile air-foam system is provided for protection of cone roof tankage. This unit consists of an air-foam truck, a foam compound supply truck, and a trailer-mounted gasoline engine driven fire pump. The air-foam truck is fitted with a water booster pump, foam compound and foam makers, and other accessories. This truck delivers air foam to the top of tank through permanently installed pipe laterals. In addition tanks have dykes in event of a rupture or boil-over. Water fog equipment is also provided and portable extinguishers are placed throughout the refinery.

The refinery has a total of 45 oil and two water tanks. Two tanks have been provided for each product except jet fuel to permit custom gaging of tank from which deliveries are made. Jet nozzles are provided on the inlet lines to the gasoline product tanks to prevent stratification of the blended product.

Products are shipped by barge, tank truck, and tank car.

Marine facilities include two tanker unloading berths and three barge loading berths. All docking facilities are rented from the city. One of the tanker berths will handle the sale of fuel oil and marine diesel bunkers and the second the receipt of crude oil.

Two four-point tank truck loading racks are situated in the marketing area. One rack handles clean products and the other dirty ones.

The tank car facilities are designed to handle two 25-car trains in from one and one-half to two working shifts. During periods of peak demand or when canals are frozen preventing barge shipments it will be possible to load 100 cars per day by operating around the clock. * * *

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FIG. 1. Coke oven plant where hydrogen is separated from gases by low temperature fractionation.

Synthetic Fuels

What Are Prospects in Australia?

Great deposits of brown and of black coal, in the populous eastern areas supply limitless raw material for synthesis

Dr. E. G. Nottes* and George E. Mapstone**

LAST year hopes were strong that the initial discovery well at Rouge Range in Western Australia signalled the bringing in of a major find in that area. Since that time five dry holes have been drilled offsetting the discovery well, indicating that, so far as can be seen now, the prospects for major production remain dim and very uncertain, at least in that region. Thus another disappointment is added to those earlier failures in finding adequate or promising production in the continent "down under," and supplies of crude still must be imported via tankers to feed the already operating and building refining capacity, that has expanded several times in the postwar period.

Up to almost the end of 1954, the various minor finds had not been sufficient for the establishment of a single producing field.[1]

Sometimes, as at Roma in Queensland, and particularly at Lakes Entrance in Victoria, several thousand barrels were produced but production soon decreased and the hope of establishing a producing field had to be abandoned. Generally geological conditions on the east of the continent are not very favorable for the occurrence of oil but in Western Australia the situation appears to be more favorable.

Early in December, 1953, it was announced that oil had been struck at Rouge Range[35]. This discovery, which was made at the shallow depth of 3600 ft, lead to a boom in oil exploration throughout Australia and created much optimism that oil had been found in payable quantities on that continent.[36] By January, 1955, the well had reached nearly 14,000 ft without finding more than a further trace of oil and gas.[37, 38] It is now accepted that the properties of the oil found indicate that it had migrated to the discovery site and that it was, in fact, only a small "fossil seepage."[39, 40] Therefore, no major field has yet been found.

Extensive drilling is continuing throughout Australia but time alone will show whether there are any commercial oil fields to be discovered on the continent or whether the disappointments of all previous Austra-

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**Chemical Engineer, SATMAR, So. Africa; formerly National Oil Pty, Australia. Fellow, Institute of Petroleum (Britain).

EXCLUSIVE

lian exploration will be repeated. With a yearly consumption of between six and seven million tons of oil products, any discoveries will have to be very extensive if they are to satisfy Australian oil requirements.

Should the hope of finding large quantities of oil in Western Australia eventually succeed, more large capital investments will be required to transport it to the refineries in the industrial areas. Western Australia, and particularly the area around the Exmouth Gulf, is very sparsely populated, as most of the population and industries are several thousand miles away on the Eastern coast. On the other hand Australia's main brown and black coal fields are handy to the industrial centers of the eastern states. Much of this coal can be mined cheaply, and in the case of the brown coal very cheaply, by the use of open pit methods. Consequently certain combined schemes for the production of synthetic fuels should eventually be competitive with imported petroleum products.

At present a relatively extensive program of refinery expansion and modernization is underway and, within the next few years, all or practically all of the gasoline, fuel oil, and lubricant requirements of the fifth continent will be met by the local refining of imported crude oil. Expenditure of $180,000,000 is involved in the various plans outlined in Table 1.

Australia's petroleum imports for 1950-51 given in Table 2 show that very considerable amounts of foreign currency are involved, much of which could be saved if indigenous raw materials can supply part or all of the imported crude oil or the finished products.[2] If the price of crude oil landed at Australian ports (e.g. Melbourne) is taken as £Aus13 = $29 per ton (£Aust1 = $2.22) this cost is of the order of at least $150,000,000 per annum. In fact this figure will be much higher as a large proportion of finished products is still imported.

TABLE 1. Current refinery construction in Australia.

	Crude topping capacity tons/annum	Cat. cracking capacity tons/annum	Locality
Anglo Iranian*	3,000,000	900,000	Kwinana, W. A.
Caltex	1,000,000	680,000	Sydney, N.S.W.
Vacuum	900,000	300,000	Melbourne, Vic.
Shell	1,000,000	not announced	Geelong, Vic.
Bitumen & oil		1,500 bbl/day platformer	Sydney, N.S.W.

*Now British Petroleum Company, Ltd.

TABLE 2. Australian Petroleum Imports 1950/51 (long tons)

Gasoline and aviation spirit	1,919,664
Kerosine and mineral turpentine	479,990
Black oils, including crude oil, once run distillates, solar oil, and residual oils	2,788,807
Total	5,188,461

FIG. 2. Typical coal and oil shale bearing formations near Glen Davis Shale plant.

Should the search for oil in Australia discover no commercial fields, or only small ones, in the next few years, all or most of Australian crude oil requirements still must be purchased overseas.

Recent events in parts of the Middle East and elsewhere have emphasized the importance and necessity of being at least partially independent of oil from areas of tension. The value of crude oil sources within the country in case of emergency is too well known to warrant further discussion.

In South Africa where the petroleum situation is somewhat similar to that in Australia, the establishment of a synthetic fuel industry involving a considerable capital outlay began operation in 1954. With the extremely low cost of coal in that country together with the fact that the industry and the coal fields are well inland from the coast and near the markets and thus have the advantage of reduced freight charges, the operation is expected to be an economic success. Eastern Germany has increased her production of synthetic fuels such as gasoline and diesel fuel from 1,050,000 tons to 1,550,000 tons per annum,[3] mainly by high pressure hydrogenation of brown coal. It would appear that the process is working economically as a certain amount of these fuels are sold at competitive prices on the Western German market which does not obtain any other synthetic fuels, but is satisfied by the import and processing of large amounts of Middle East crudes.

Historical Developments

As early as 1928 one of the largest British chemical enterprises had studied the possibilities of the establishment of a pilot plant for coal liquefaction in Australia. In 1934 the Commonwealth Hydrogenation Committee was formed and Dr. H. Herman and Sir David Rivett collected necessary information and issued a report.[4] The coals considered were the brown coal from Yallourn, Victoria, and the black coal from the Maitland field in New South Wales. It was estimated that, for a plant designed to produce 150,000 tons per annum, which was considered to be the minimum economic size, a capital outlay of £Aust11-12 million was required. This was equivalent to something like $20 to $25,000,000 — and in 1937 the results of extensive research conducted by the British Fuel Research Station on Victorian brown coals were very favorable. Yields of up to 50 per cent of gasoline in addition to diesel oil were obtained. The Motor Method octane number of the gasoline was 66 clear and 74 with 1 cc of TEL per Imperial gallon.

A firm of British coal experts has examined the suitability of some of the huge reserves of black coal in the State of Queensland for the production of liquid fuels.[5] The results of their investigations convinced the Queensland Government that the production of liquid fuels, particularly from the Blair Athol field, would be of strategic importance and that the plan would also be able to pay its way economically. It was estimated that the most favorable method should produce gasoline at a cost of less than 10d per Imperial gallon (i.e. less than 9 cents per U. S. gallon). The cost of a plant capable of producing 80,000,000 gal of gasoline and 20,000,000 gal of other fuels and byproducts per year was estimated to be £30 million or $66,000,000. It was reported, however, that the present federal government has refused to put money into the project.

The Victorian state government has encouraged the Victorian Gas and Fuel

XUM

Corporation to go ahead with a plan that appears to be sound economically. Victorian brown coal will soon be gasified with oxygen and steam under pressure by means of the Lurgi process to produce badly needed town gas for greater Melbourne. It is planned to expand the plant at Morwell and Yallourn by the addition of a Fischer-Tropsch plant[6] which will produce 12,000,000 gal of gasoline and 12,500,000 gal of oils per year from off-peak gas production.[7]

Possibility of a similar project in the state of New South Wales is being studied at present. The western coal fields around Lithgow can supply large amounts of high ash coal suitable for oxygen pressure gasification. This coal could be produced relatively cheaply, much of it by open cut methods in the Wallerawang area near Lithgow.[6]

Synthetic Fuels

Oil Shale.

Australia has some deposits of oil shale, as well as suitable coal deposits, which have been shown to be the richest in the world. Over 200 gal per ton have been recorded for some deposits[8] and one enterprise, National Oil Pty. Ltd., operating at Glen Davis about 150 miles from Sydney, recovered an average of about 50 gal per ton over several years operation, using modified Pumpherston retorts.[8,9,10] There are many other deposits of oil shale in the state of New South Wales[11] and in Queensland.[12] In contrast to those in N.S.W. the Queensland deposits still await exploitation.

Crude shale oil produced at Glen Davis up to 1952 and at Marangaroo during the war[13] was of a mixed base paraffin-naphthene type crude. It proved to be an excellent charge stock for thermal cracking, and the light spirit or naphtha recovered from the carbonization gases was readily reformed thermally on large-scale runs. Years of successful operation have shown that, after some initial difficulties were overcome, no more processing troubles were experienced in the retorting and cracking of crude shale oil, thermal reforming of the naphtha, and in the production of high octane polymer gasoline from the olefinic cracked gases, than are usual when processing natural crude oils. From a technical viewpoint the application of these processes to Australian shale oils at Glen Davis has been a definite success.[10]

TABLE 3. Production of gasoline from crude oil at Glen Davis.[14]
(Standard Specification 70–72 M.M. O.N.)

1947	4,063,628	Imperial gallons
1948	3,128,000	Imperial gallons
1949	2,611,000	Imperial gallons
1950	2,426,000	Imperial gallons
1951	2,300,000	Imperial gallons
1952	500,000	Imperial gallons

FIG. 3. Coal-producing areas in Australia.

Oil Shale Mining Costly — The main reason for the closing of the industries was the high cost of mining the oil shale under Australian conditions. This was due principally to the thin seams, which are rarely even 5 ft thick, and to the fact that skilled oil shale miners were not obtainable in sufficient numbers for the shale output to reach economic figures. The low mine output meant that the retorts and refinery were unable to maintain full production throughout the year and, instead of the anticipated 10,000,000 gal of gasoline per year only a fraction of that amount was produced. The production of gasoline at the Glen Davis refinery over the past few years is given in Table 3.[14] In 1952 the retail selling price of imported gasolines was 3 shillings and 5 pence per Imperial gallon, while the cost of production of the shale gasoline reached a figure of approximately five shillings per gallon. The federal government, as the main shareholder in the company, did not subsidize the price difference and production was stopped.

It therefore appears that it is only in times of emergency and great shortage of foreign currency that Australian oil shales warrant further consideration as raw material for gasoline production. Development of improved methods of mining the relatively thin seams of oil shale, however, could alter the situation.

TABLE 4. Australian coal reserves.[11,*]
(millions of tons)

State	Black coal	Lignites and brown coal
New South Wales	11,688	50
Queensland	1,704	67
Tasmania	244	
Victoria	33	37,000
South Australia		650
Western Australia		800
Northern Territory	Unexplored for coal	

* These reserves have been proved by mining or boring and list only commercially recoverable coal. Latest surveys have indicated that the reserves are higher than those listed, e.g. one author alone gives an estimate of 50,000 million tons of brown coal in Victoria alone (15).

Coal.

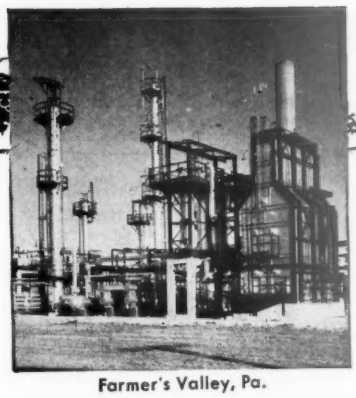
The eastern part of the Australian continent is blessed with large deposits of black and brown coal close to the main centers of industry and population. It can be said that Sydney lives on black coal and Melbourne on brown coal. Table 4 lists a conservative estimate of the coal reserves of the fifth continent, large areas of which have been only partly surveyed and prospected for coal. The map in Fig. 3 shows location of important deposits.

Practical Possibilities — At present it appears that the high pressure hydrogenation of coal, coal tars, and topped petroleum residues has been and is probably still providing the larger part of the synthetic fuel production throughout the world, the bulk of the remainder being produced by the Fischer-Tropsch process or its modifications. The output of plants for the high pressure hydrogenation of coal, tars and petroleum residues by the Bergius-I.G. process has been increased remarkably in Central and Eastern Europe over the past few years.[3] New coal hydrogenation capacity has been brought on stream since 1945 on some of the coal fields adjacent to the Eastern European countries. The successful combination of cracking with high pressure hydrogenation of petroleum residues with the relatively cheap hydrogen obtained as a by-product from

TABLE 5. Properties of Yallourn brown coal.[17]

	New open cut Per cent	Old open cut Per cent
Moisture	66.3	50.0
Volatile matter	17.4	26.0
Fixed carbon	15.4	22.0
Ash	0.6	2.0
Calorific value wet (gross)	3,752 Btu/lb.	5,575 Btu/lb.
Calorific value dry (gross)	11,126 Btu/lb.	11,150 Btu/lb.

three heads are not necessarily better than one



Farmer's Valley, Pa.

It's a fact. More than one head can very well lead to confusion, delusion and costly conclusions.

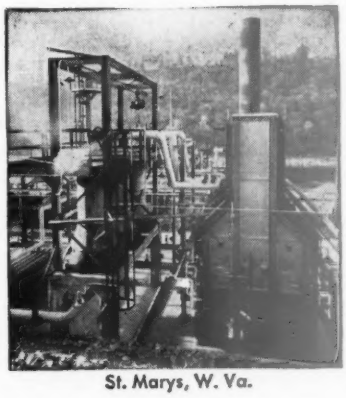
Petroleum refiners, in particular, have found this to be true after placing their multiplant expansion programs in the hands of several different process construction organizations. Believing this would result in greater efficiencies, they discovered too late that such an arrangement was creating—not —solving problems.

This potential pitfall was avoided by Quaker State Oil Refining Corporation when they selected Procon for the expansion of their three refineries. For Quaker State this meant working with one organization . . . having one organization responsible for the completion of all three projects.

Procon's work for Quaker State included the erection of three UOP Platforming units. A 1,500 barrel-per-stream day unit was installed at Farmer's Valley, Pa., while 1,000 barrel-per-stream day units were constructed at Emlenton, Pa. and at St. Marys, W. Va.

Quaker State's satisfaction in the three jobs completed for them by Procon is proof enough that three heads aren't necessarily better than one.

Emlenton, Pa.



St. Marys, W. Va.

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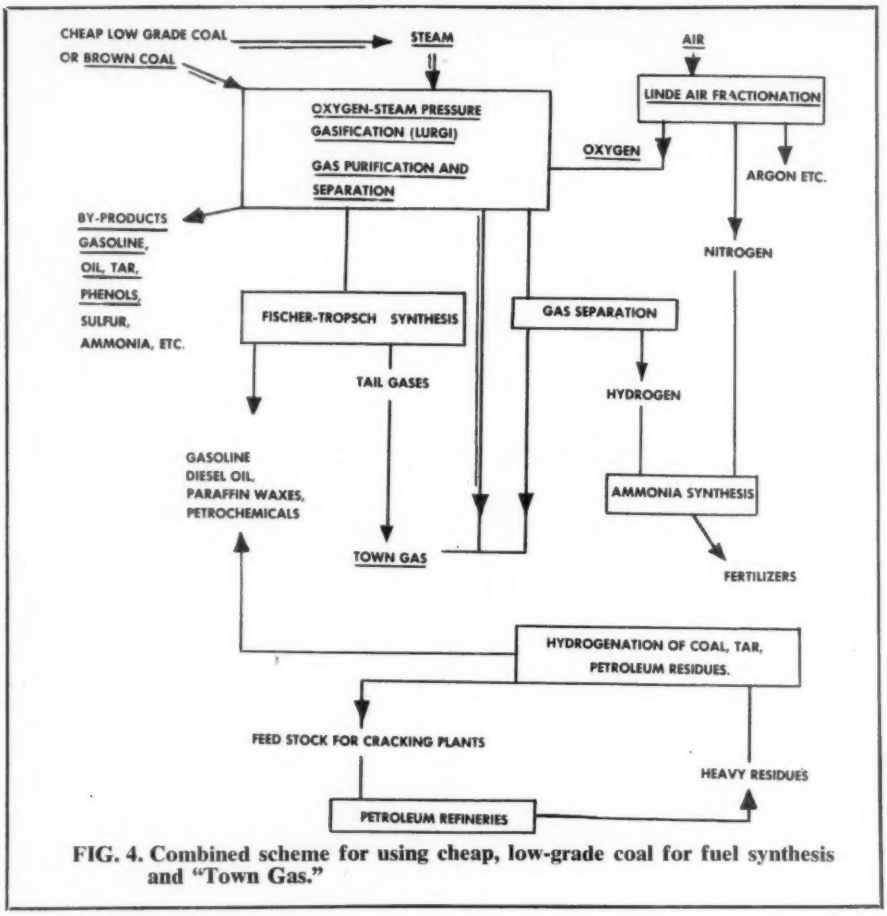

FIG. 4. Combined scheme for using cheap, low-grade coal for fuel synthesis and "Town Gas."

coke oven operation in Western Germany has been described thoroughly elsewhere.[16]

The huge reserves of brown coal, which are ideally situated close to the great industrial metropolis of Melbourne, should provide a very favorable basis not only for any fuel synthesis process, but especially for coal liquefaction by high pressure hydrogenation. The estimated reserves of brown coal in Victoria of 37,000 to 50,000 million tons[15] are principally within a radius of 100 miles of Melbourne, a city of 1,500,000 inhabitants and possessing first class harbor facilities. Throughout the Yallourn area the thickness of the coal seam exceeds 200 ft with an average overburden of only 50 ft. At present more than 7,000,000 tons of brown coal are mined annually for the generation of electricity and for the manufacture of briquettes for industrial and domestic use.

The properties of the Yallourn brown coal are given in Table 5. The freshly mined coal has an average moisture content of over 50 per cent, which is normally reduced on drying to about 15 per cent; however, the freshly mined coal can be burned satisfactorily in steam boilers. The average composition of the brown coal delivered to the power station from the Yallourn open cut over the years 1941-1945 is given in Table 6. Comparison of this coal with the brown coal used for the production of synthetic fuels at the Wesseling hydrogenation works in Germany shows a striking similarity between them, though the lower ash content of the Australian coal (Table 6) suggests that it should be superior to the German coal which has been very successfully hydrogenated at Wesseling. Pilot plant runs on the Australian brown coals have shown that they are suitable for high pressure hydrogenation under conditions similar to those that have been employed for several years at Leuna in Germany.[19] For comparison, the analysis of the brown coal which is hydrogenated in large amounts at Leuna is also included in Table 6.

The analysis of the ash suggests that, because of the lower lime content of the Yallourn coal, troubles due to the "caviar" deposits in the high pressure reaction vessels[20] should be less with the Australian than with the German coal. The ash also contains less abrasive material than that of many of the sandy German brown coals. It can reasonably be assumed that the erosion and abrasion effects in the high pressure heater tubes, let down valves, etc., should therefore be less than with the Leuna coals, thus giving even easier operation and smoother operation.

The Yallourn brown coal is not only a very suitable raw material for hydrogenation, but it is also very suitable for production of hydrogen.

Low temperature gasification of Victorian brown coal by one process[20] has given gas yields ranging from 4000 to 10,000 cu ft per ton of raw coal. The gas contained 20-30 per cent carbon dioxide, 6-23 per cent methane and 32-47 per cent hydrogen. At the same time from 3 to 8 gal of tar per ton of dry coal were obtained. These tars have been found suitable for hydrogenation.

Products of the hydrogenation of bituminous black coals are largely aromatic and naphthenic in character, while appreciable yields of paraffins are obtained from the hydrogenation of brown coals.[21] Recent research has also shown that the mechanically separable constituents of banded American black coals, namely the anthraxylon, spores, resins, fusain, attrital matter, etc., are liquefied by hydrogen at greatly differing rates and extents. Those constituents of low or intermediate rank coals that are translucent in thin sections under the microscope are liquefied completely, while the opaque constituents, principally fusain, remain unattacked to the extent of from 20 to 95 per cent.[21] The products of the hydrogenation of spores, resins, and algae remains are oils of low density and contain a high proportion of saturated hydrocarbons. On the other hand, the products from the hydrogenation of the anthraxylon, which is the principal constituent of bright coals, contain higher percentages of aromatic hydrocarbons and phenols.

Recent work on New South Wales coals[22] has shown that, in general, Australian coals do not exhibit the well defined banded appearance usually associated with European and American coals. The dull bands of Australian coals are usually an intimate mixture of dull and bright coal. Many of the N.S.W. coal seams are exceptionally thick when compared with seams in the Northern hemisphere. For example some of the seams average from 15 to 40 ft thick. It is obvious that the application of modern mining methods to such seams should be able to provide coal more cheaply than, by way of example, in Europe.

The more important deposits of

TABLE 6. Comparison of Australian and German brown coals.

	Yallourn Australia (15,17)	Wesseling Germany (18)	Leuna Germany (18)
Ultimate Analysis (Dry basis) Per cent			
Carbon	65.64	64.20	61
Hydrogen	4.58	4.43	6
Nitrogen	0.50	1.11	1
Sulfur	0.26	0.25	7
Oxygen	26.84	23.61	19
Ash	2.17	6.08	6
Ash analysis, Per cent			
Al_2O_3	1.7		4.3
Fe_2O_3	33.4		15.0
SiO_2	1.2		5.6
CaO	11.2		36.0
Mgo	19.5		4.6
$Na_2O + K_2O$	7.6		1.1
SO_3	25.4		8.4
Cl	0.0		25.0

FIG. 5. Absorption towers in a Fischer-Tropsch plant.

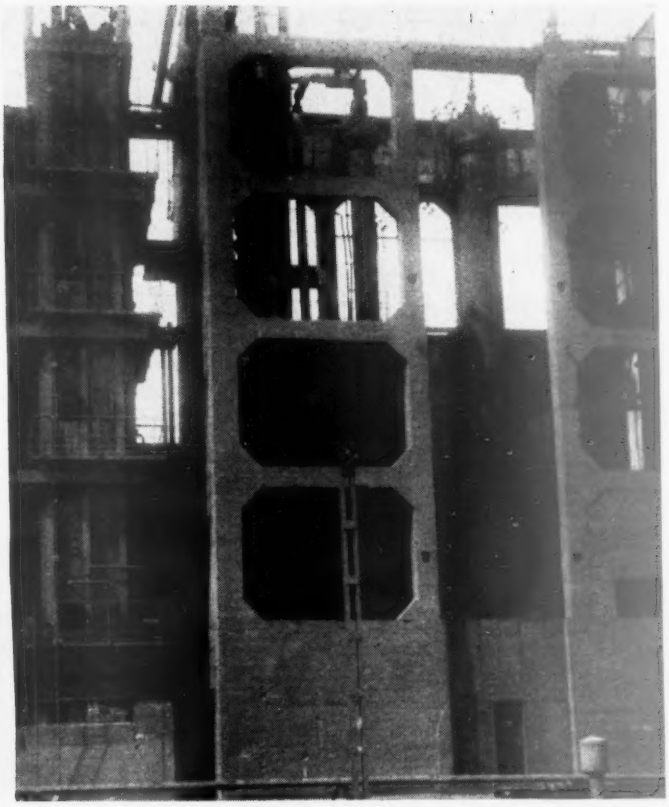

FIG. 6. High pressure "stall" for hydrogenation of coal.

black coal are located in the Eastern States of Queensland and New South Wales, and most of them are near the main centers of population and industry. The most suitable coal for hydrogenation is that from the Maitland field near Newcastle. This high volatile, low ash coal is readily gasified and is used extensively for the manufacture of town gas. Some of the other N.S.W. coals are relatively high in ash but quite a number have good coking properties. They can provide a favorable source material for the production of synthesis gas as has been suggested for some of the open-cut coals from the Western coal fields. It has been proposed that these coals be gasified by the Lurgi process using oxygen and steam under pressure, for the production of town gas, and later for the production of synthesis gas for a Fischer-Tropsch plant also.[6] They could also be used for the production of hydrogen for coal liquefaction if required. Some characteristics of representative coals from the N.S.W. fields are given in Table 7.

As has been mentioned previously, hydrogenation tests with some of these coals have given encouraging results, particularly with the coal from the thick seams of the Maitland field, which can be hydrogenated under similar conditions to those used for the liquefaction of Ruhr coals at present. Table 8 compares the Maitland coal with a Ruhr coal which is hydrogenated at the Scholven plant.

TABLE 7. Some representative New South Wales coals.[11,22]

FIELD	New-castle	Mait-land	Sou-thern	Wes-tern
Moisture %	2.2	2.0	0.5	1.6
Volatiles %	35.0	41.0	24.9	33.4
Fixed carbon %	54.8	51.4	65.3	52.5
Ash %	8.0	5.5	9.3	12.5
Cal. value Btu/lb.	13,170	13,900	13,800	12,550

Hydrogen.

In any process for the production of synthetic fuels hydrogen plays at least as important a role as does the material being hydrogenated whether it be coal, coal tar, petroleum residues or carbon monoxide. Whether it is high pressure hydrogenation or Fischer-Tropsch synthesis the production of hydrogen is extremely important as it involves the main cost factor. Actually the cost of producing hydrogen of the required purity is the determining factor in the economics of any synthetic fuel process. As natural gas is not available in sufficient quantities in Australia hydrogen would have to be produced from coke, or preferably from coal by one of the latest gasification methods.

Under European conditions the cost of pure hydrogen from the gasification of hard coke with oxygen is about 8-15 per cent higher than from the old "make and blow" process. Oxygen gasification, however, has its place in the production of hydrogen from fuels which are not suitable for the "make and blow" process but which are much cheaper than hard coke.[23] The cost of the synthesis gas (a mixture of carbon monoxide and hydrogen), accounts for 70 per cent of the cost of the final gasoline product from the Fischer-Tropsch process and the cost of compressed hydrogen for the high pressure hydrogenation of coal is about half of the total cost.[24] At present it appears that the best solution on a large scale would be the gasification of the relatively cheap, high ash coals from the Western N.S.W. coal fields by means of oxygen under pressure.

Tests on the coal from the Western coal field near Lithgow have proved it to be very suitable for the production of synthesis gas by the Lurgi process, and a large plant to be erected at Wallerawang and based on this process is at present in the planning stage.

As the Lurgi and Fischer-Tropsch processes have made remarkable progress of late, both from the technical and economic points of view, great interest has been manifested in Australia in the production of town gas, etc., by these methods.[6] The cost of producing town gas is largely dependent on the price of coal the readily available and relatively cheap high ash coal from the Wallerawang area, or the cheap Victorian brown coal are the

TABLE 8. Comparison of Maitland coal with a Ruhr coal as used for hydrogenation.

	Maitland [11,22]	Scholven (Ruhr) [18]
Carbon (d.a.f. basis) %	82.9	82.8
Hydrogen (d.a.f. basis) %	6.0	5.2
Nitrogen (d.a.f. basis) %	2.1	0.5
Sulfur (d.a.f. basis) %	0.9	1.0
Oxygen (d.a.f. basis) %	8.1	10.5
Ash %	5.0	4.6

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natural choice for any such project.

Technically the process involves blowing a mixture of oxygen and steam through the coal bed at pressures of the order of 20 atmospheres (300 psig) and at sufficiently high temperatures. A methane-rich water gas is produced having a calorific value of approximately 4000 Cal./m.³ The raw gas is purified readily by scrubbing with methanol under pressure at sub-zero temperature (the Rectisol process).[25,26,27,28] Should any further purification be required for the removal of traces of sulfur compounds, which is not likely, this should be more readily achieved with Australian than with German coals because of the lower sulfur content of the former coals. (e.g. Table 6.)

As mentioned earlier, the production of town gas for the city of Melbourne will soon be increased by a Lurgi plant being erected, and designed to use the cheap brown coal from the open-cut workings at Moorewell and Yallourn. The first units, which are planned to begin operation in 1956 will consume 126,000 tons of brown coal briquettes for the production of 4380 million cu ft of gas and a total of 1,350,000 gal of tar and liquid by-products. It is planned to extend the works generally so that by 1976 annual production will be 60,000 million cu ft of gas, 20,000,000 gal of oil, 13,000,000 gal of tar, 5,000,000 gal of gasoline and 1,500,000 gal of solvents.[6]

The use of other modern techniques such as the fluidized bed process in Winkler large scale gas generators will probably be considered also. The Commonwealth Scientific and Industrial Research Organization (CSIRO), which holds a somewhat similar position in Australia to the Bureau of Mines in the USA, is at present conducting extensive studies in coal gasification with particular attention to fluidized bed techniques.[29] As a result of this research the required know-how will be available when required.

Cost Estimates

The cost of production of synthetic fuels in the U.S.A. has been estimated several times and very thoroughly over the past year or so.[30,31] It is therefore most interesting to reconsider such costs from an Australian viewpoint as conditions on the fifth continent are different from those in the U.S.A. and somwehat more favorable for the establishment of such a project.

TABLE 9. Production costs for coal hydrogenation in Australia.

(Estimated cost per ton of gasoline in shillings (Aust.) per ton. 1/—Aust = 11.1c.) (/ = Shilling, Aust.)

Raw Materials	
Brown Coal: 4.5 ton @ 10/— per ton	45/—
Brown coal tar: 0.2 ton @ 300/— per ton	60/—
Make up gas: 2220m³ @ 0.15/— per m³	333/—
Catalysts and other chemicals	12/—
Operating costs (from Table 10)	763/—
Total	1213/—
Less credits:	
Recycle hydrogenation gas (H_2); phenols; C2, C_3, and C_4 hydrocarbons; tar and petrochemicals, sulfate of ammonia and other by-products.	372/—
Production cost for one ton of gasoline	841/—

The cost of 1 Imp gal (1.2 U.S. gal) should then come to 2.77/— (Specific Gravity of hydrogenation gasolines = 0.730). This is equivalent to 25.2 cents per U.S. gallon.

Capital Costs

Estimated capital cost for a modern coal hydrogenation plant in the U.S.A. has been given in some recent publications.[31] A plant producing 30,000 bbl per day, or approximately 1,000,000 tons of gasoline per annum would probably involve the investment of $404,000,000 according to estimates by EBASCO. This should be equivalent to £Aust180,000,000. A plant producing about 600,000 tons of gasoline per annum would cost about £Aust100,000,000. It has been estimated[18] that a realistic figure for capital cost is about £Stg60 (£Aust75) per ton per annum capacity. Cost of one German plant with a capacity of 460,000 tons of gasoline per annum has been given as the equivalent of £Aust35,000,000 in 1945. After allowing for the inflation in Australia since 1945 a figure of roughly £Aust100,000,000 ($222,000,000) for a plant with an annual capacity of 600,000 tons does not appear to be excessive at the present time. In this regard it should also be borne in mind that, because of very favorable circumstances, Australia is able to produce the world's cheapest steel.

A very rough estimate of the costs for a 600,000 ton/annum coal hydrogenation plant operating under present Australian conditions is given in Table 9, and a short build up of estimated operating costs is given in Table 10. For comparison an analysis of the costs that make up the final selling price of imported gasoline in Australia is given in Table 11.[2] This shows that, without the imposition of duty and primage or other excise on the locally produced synthetic gasoline, it would be able to compete with imported gasoline at the filling station.

TABLE 10. Break down of operating costs.

(in shillings Aust. per ton of gasoline produced)

Labor costs:		
Wages: 6.2 hr based on a 40 hr week @ 7/— per hr	43/—	
Salaries: 1.2 hr @ 12.5/— per hr	15/—	
	58/—	58/—
Energy costs:		
Water 140m³ @ 0.25/— per m³		35/—
Steam 6 ton @ 10/— per ton		60/—
Electricity 260 KWH @ 0.10/— per KWH		26/—
Fuel gas 2700m³		40/—
Brown coal 0.6 ton @ 10/— per ton		6/—
Maintainence:		
Wages and salaries		50/—
Material		20/—
Workshop		80/—
General works charges		20/—
Capital charges depreciation including buildings etc. based on £100,000,000 with 7% interest and an annual production of 600,000 tons of gasoline per annum		234/—
Return on capital (say 4%)		134/—
Total operating costs		763/—

The great flexibility of high pressure hydrogenation has proved of great

There is, of course, one big drawback that would have to be overcome with such a large project. The investment of such large amounts of capital could not be considered by private enterprise alone. Strategic considerations or the urgent need to conserve foreign currency could, perhaps, sooner or later influence a government decision to establish such a plant. At present it is more likely that side enterprises developing out of the present enlargement of city gas production schemes will introduce fuel synthesis to Australia. By-product gasoline, diesel, and fuel oils, etc., that are to be produced in the brown coal gasification scheme at Yallourn will almost certainly be able to compete on the open market with the products of Australian refineries processing imported crude.

The use of Fischer-Tropsch synthesis schemes on a relatively moderate scale and using the surplus gas from off-peak production, especially at night, will probably prove to be economically feasible. There can be no doubt that the outcome of the great system that is due to commence operations at Sasolberg in South Africa later this year on the production of synthetic fuels from coal will influence a decision in Australia.

Much research and development work has been put into synthetic fuel production methods since the end of the last war. Process economics have been improved and technical progress has been achieved in many directions[32,33] The ability to gasify all kinds of coal with oxygen and steam under pressure has made possible the economic production of large amounts of relatively cheap synthesis gas from very inferior coals. The Fischer-Tropsch process has been considerably improved by the application of modern engineering techniques including fluidized bed methods and cooling oil recycle in the synthesis reactors.

TABLE 11. Breakdown of retail gasoline price in Australia.[2]

(1/— = 12d) (d = pence)

F.O.B. cost 10 cents per U.S. gal	13 d per Imp. gal.
Freight and insurance	6.5 d per Imp. gal.
Duty and primage	11.25d per Imp. gal.
Storage, handling, delivery and overhead	7 d per Imp. gal.
Retailers margin	3.75d per Imp. gal.
Selling price of imported gasoline	41.5 d per Imp. gal.

(This is equivalent to 32 cents per U.S. gallon).

On this basis the selling price per Imp. gallon of synthetic gasoline would be:

Production cost (from Table 9) 2.77/— =	33.2 d
Storage, handling, etc.	7 d
Retailers' margin	3.75d
Selling price of synthetic gasoline	43.95d per Imp. gal.

(This is equivalent to 33.8 cents per U.S. gallon)

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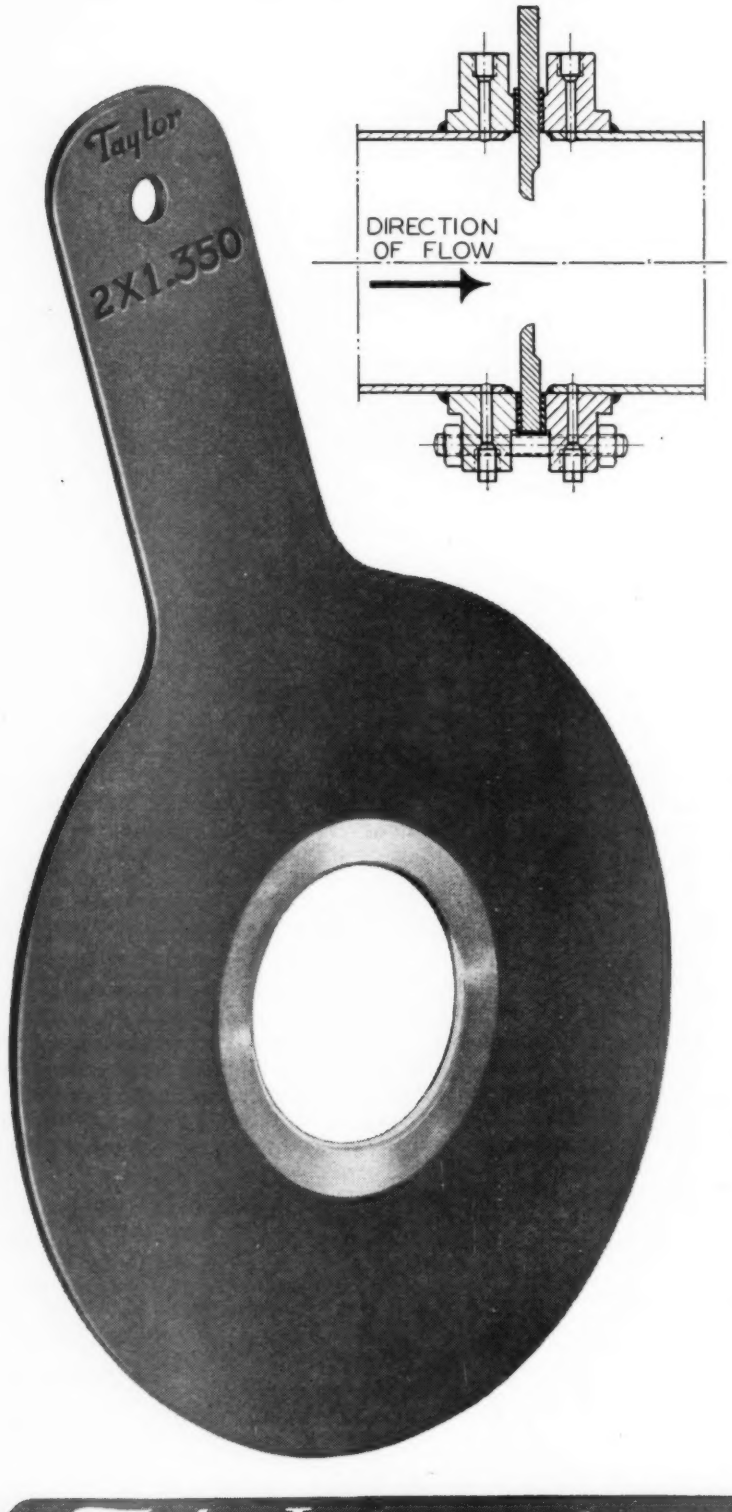

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value in that it has allowed the plants to switch overnight from the liquefaction of coal to the hydrogenation of petroleum residues now that coal prices in Europe have risen. If circumstances changed it would be easy to switch the plants back to coal hydrogenation.[84]

Existing or Planned Facilities

Flexibility of the high pressure coal and coal tar hydrogenation processes has been demonstrated recently in Europe on a large scale. Coal prices increased considerably in the years following the war to an extent that coal hydrogenation could not compete economically with petroleum products. Almost theoretical yields of high quality gasolines and diesel fuels were easily obtained by switching from the hydrogenation of coal to the hydrogenation of crude oil residues.

In this way a surplus of heavy residues from cracking operations that cannot be absorbed by the market can be hydrogenated with the production of valuable distillate fractions such as gasoline, etc. Residues from this distillation, being richer in hydrogen than before, can be used as charging stock for the cracking plants. In this way it is possible to effect an essentially complete conversion of the oil to light and medium products and eliminate disposal of surplus low grade residues.

Projects such as this could be adopted in Australia and could lead to the eventual balanced integration of a future coal or oil hydrogenation plant into the present refinery scheme being developed there at present. Surplus residual oils from the Australian refineries could thus be used either as additions to coal paste oils or alone as feed for high pressure hydrogenation units. This combination could be especially valuable in times of national emergency or lack of foreign currency. In the event of the recent discovery of oil in Western Australia proving extensive, such a combined plan would make possible a well balanced integration of coal and oil processing. The beneficial effect of the home production of the various by-products which provide the basic raw materials, much of which are at present imported for the expanding chemical industries, is obvious.

Australia's extensive deposits of all grades of coal, situated so closely to the main industrial and population centers, are certainly an invitation and a challenge to consider their use for the production of synthetic fuels and chemical by-products.

Summary

Although oil has been found several times in Australia no commercial fields have been produced up to the present.

Australia has large reserves of black and brown coal, and the location of many of them close to the main industrial and population centers on the east of the continent should make possible schemes for their use for fuel synthesis by modern methods. Both the improved high pressure hydrogenation and pressure gasification with steam and oxygen followed by Fischer-Tropsch synthesis may be considered. The integration of one or the other of these processes into the oil refinery expansion program at present going ahead in Australia should be advantageous both for the refineries and for chemical industries. Such a plan would render the fifth continent less vulnerable in the event of an international emergency, besides strengthening her foreign currency position. Relatively long and vulnerable routes for oil tankers may sooner or later influence the government to consider the establishment of a synthetic fuel industry.

High pressure hydrogenation on a comparatively large scale is technically possible but requires a very large capital investment, and though close to being economic, would require some government assistance. Smaller plants employing the latest versions of the Fischer-Tropsch process combined with the oxygen-steam pressure-gasification of low grade coals for town gas production which has been planned and is being installed, need less capital investment and appear to be the better answer to the problem at present.

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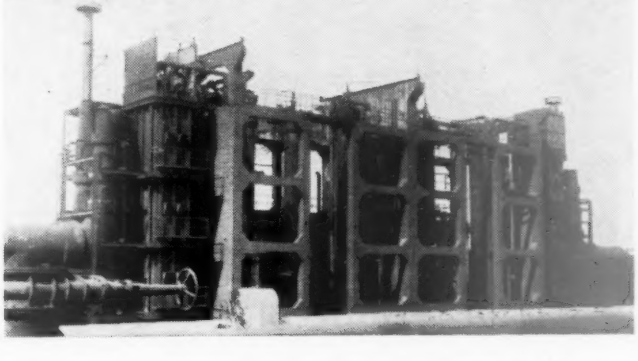
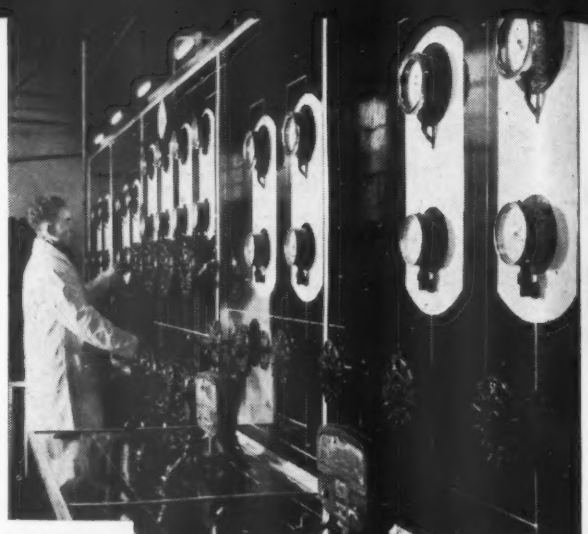
Fischer-Tropsch synthesis reaction vessels.

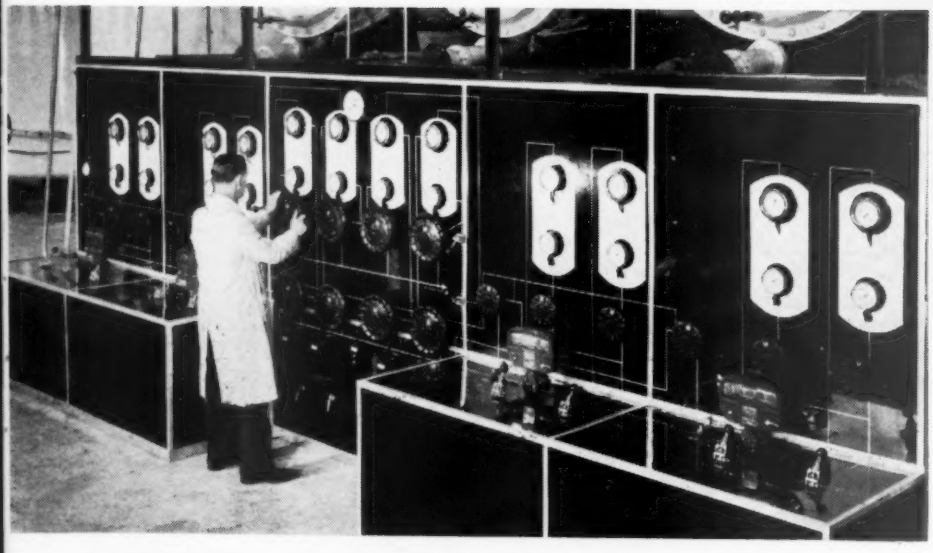


High Pressure hydrogenation stalls.

AUTOMATIC CONTROL



View of main control panel, and close-up of one of the panels therein, at Fina's Millwall, London, blending unit.

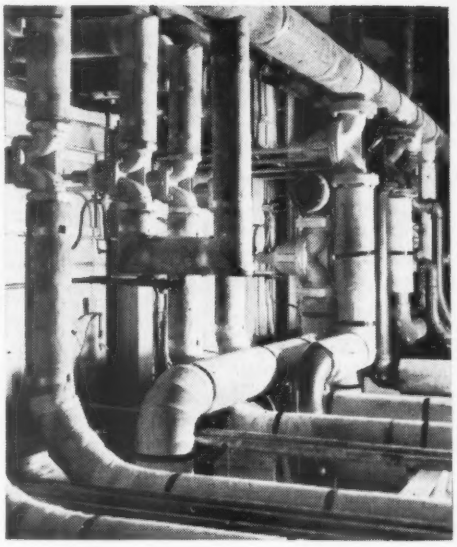


COMPRESSED AIR OPERATED LUBE BLENDING PLANT

Walter Sekules*

THE Fina Company's new oil blending plant in Millwall, London, England, is claimed to be one of the first in that country to be thermostatically controlled, steam-heated and operated by compressed air. Designed to supply lubricating oils in bulk, as well as in barrels and drums, the plant was built within six months to the design of W. R. Sharp, Fina's assistant chief engineer in England.

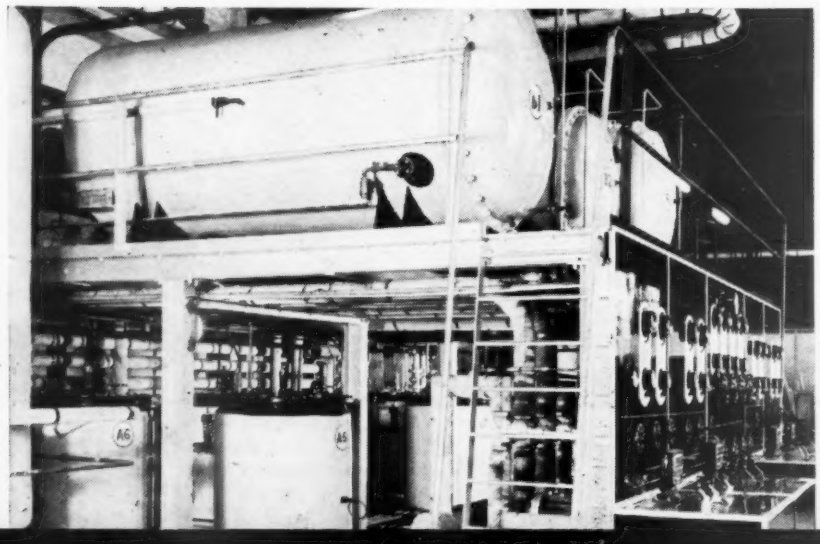
*European correspondent.

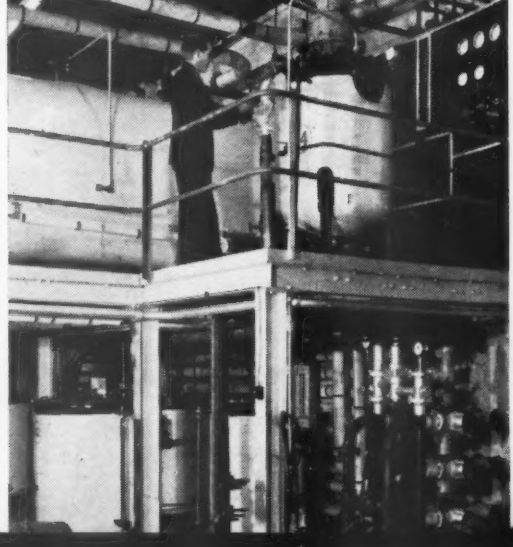


Complicated maze of piping back of the control panel.

A miniature control panel to handle the additives is shown back of the small blending mixer. The gage shown is calibrated carefully, to control accurately the addition of small amounts of additives to the blends as required.

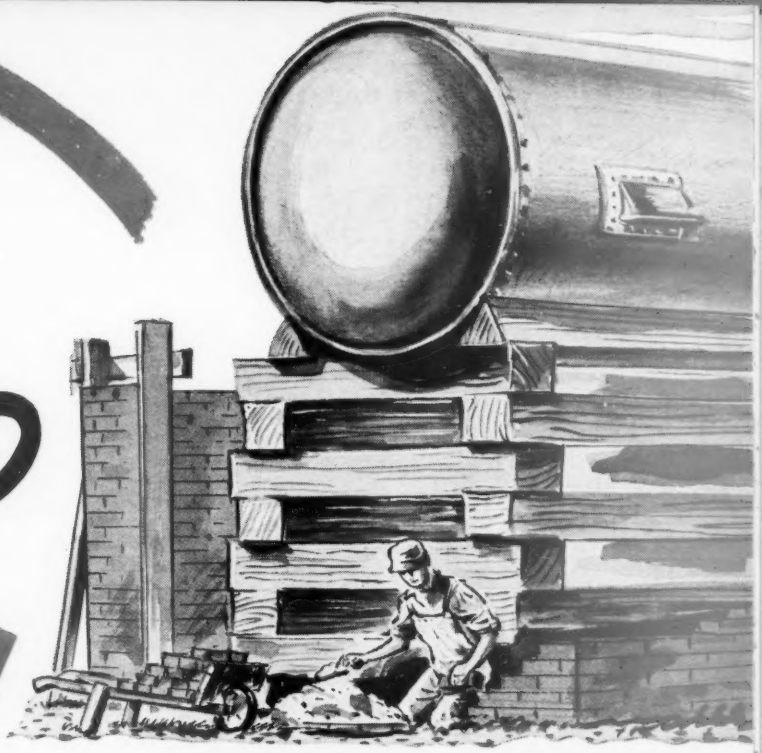
Various additives are stored in these tanks, ready to be added to the blend via the electric motor-driven agitators.





XUM

WHEN HEAT MUST BE ENCLOSED



In the old days some grate bars and a brick wall were the prime materials needed for a heat enclosure. Today industry demands higher temperatures, lower heat loss and greater efficiency.

And how can this be accomplished? By the selection of correct material, — a design that comes from experience, — responsibility for correct application. And where can you get this combination? Only from heat enclosure headquarters — DETRICK.

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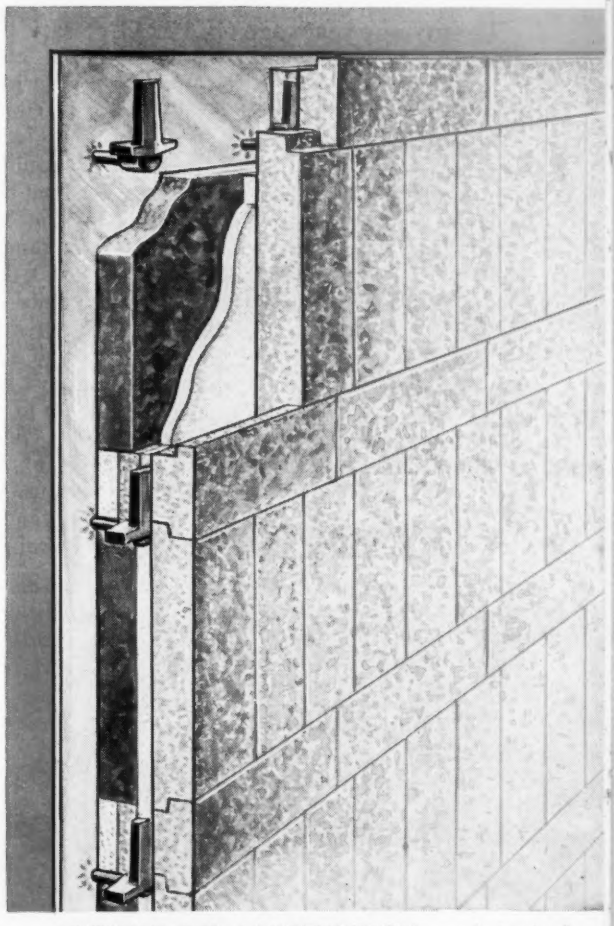

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For more detailed information on this subject send for our booklet entitled "HEAT ENCLOSURE METHODS by DETRICK". If it's a problem of enclosing heat it's a job for DETRICK.

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DETRICK Heat ENCLOSURES

DETRICK
HEAT ENCLOSURES

Postwar revamping of old topping plant supplies local product demands; has complete harbor installation

Grangemouth Refinery

a complex operation

THE Scottish Oils Ltd., a member of the Anglo-Iranian Oil Company (AIOC) is singular in the petroleum industry for the diversity of its operations. It has in Grangemouth one of the most modern refineries; operates the only crude oil trunk pipe line in Britain; and produces oil from shale. Just over a century ago Dr. James Young, a Glasgow chemist, patented a process for producing oil from coal. And the industry has registered phenomenal progress since he produced oil from coal and later from shale.

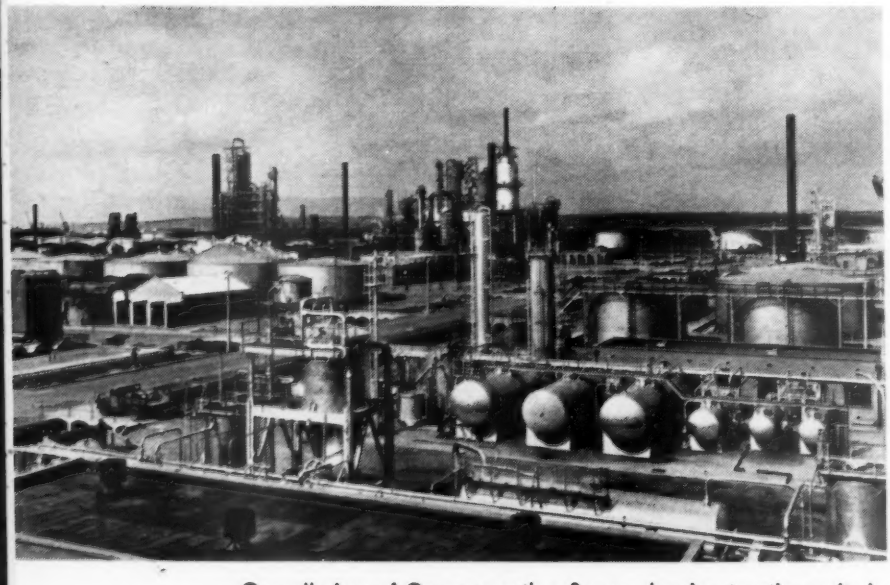
Twenty-one years ago (in 1924) this company commissioned a refinery at Grangetown for treating imported crude with one crude still distillation unit, one bench of steam-heated stills for the separation of kerosine from motor spirit and treatment units for the finishing of motor spirit and kerosine. Two cracking units were added in 1930 to produce an improved grade of motor fuel, and a solvent extraction unit was installed to produce a superfine lamp oil and tractor vaporizing oil. These cracking units were subsequently converted to crude distillation to augment the refinery throughput. The old installation operated at the moderate output rate of 2,100,000 bbl a year until lack of crude oil supplies caused it to be closed down during the second World War.

EXCLUSIVE

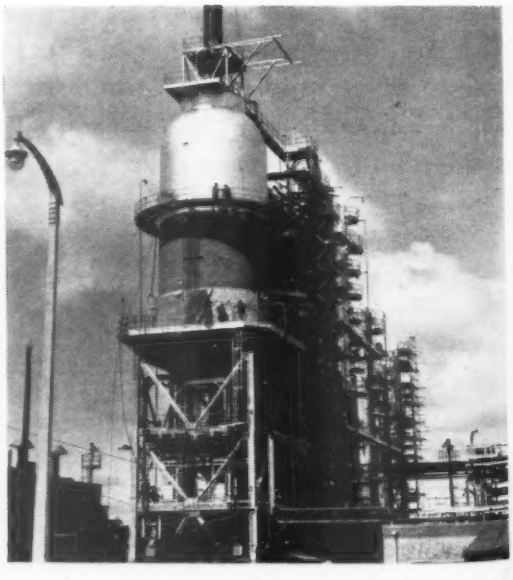
Construction of the enlarged refinery commenced in 1949 when AIOC required additional capacity in Scotland to meet its normal market expansion. The post-war expansion scheme at Grangetown was completed recently with the commissioning of the last three units—a 420,000-bbl a year catalytic polymerization unit, a Girbotol unit and a sulfur recovery unit. The refinery's throughput has now been stepped up to about 18,900,000 bbl a year.

The refinery stands on the south bank of the Firth of Forth on a 500-acre site near the seaport town of Grangemouth. Facing the main road forming its southern boundary are buildings for offices, laboratory, and powerhouse. A housing estate to the west accommodates key workers. Behind are the various refining units grouped systematically in a gridiron pattern on both sides of the highway bisecting the plant. Along the riverside is the tank farm where stocks of crude oil are stored and finished products wait dispatch. The main areas have been designed and sited with a view to future expansion. The 80-mile-long system of pipes linking the main areas is housed in open pipeways at ground level to facilitate maintenance and prevent accidents.

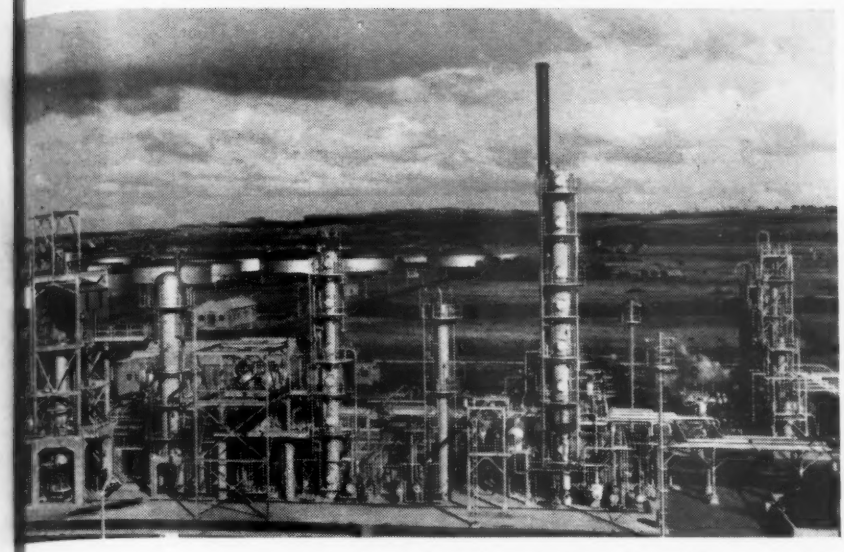
The refinery site is extremely flat and lies only a few inches above the high water mark of the adjacent Firth of Forth. To remove the real risk of flooding, and to prevent the site's becoming a morass during the construction phase, the entire area was raised by tipping onto it spent shale from the Scottish Oils Retorting Works 12 miles away. Over 3,500,000 bbl of this material were conveyed to the site by road and spread to a depth of approximately two feet.



Overall view of Grangemouth refinery, showing treating units in foreground, primary distillation and cat cracking plants, background.



Fluid cat cracking unit, with regenerator tower in foreground.



Catalytic polymerization unit, making motor fuel component from olefinic gases from cat cracking unit.

Phosphoric acid unit for treating cracked naphtha, including rerun tower.

Beneath the original surface there is a layer of silty mud, over 100 ft deep, that rendered the load-bearing value of the ground inadequate to carry a modern refining plant. To overcome this difficulty specially designed foundations of reinforced concrete were built on the surface from precast sections to form rectangular cells rather like an egg box. Earth was then removed from the bottom of each cell, causing the egg box to sink by its own weight until it was flush with the ground level. A bottom section and later, a top section or lid were put in so that the whole formed a buoyant raft capable of supporting the weight of equipment to be built upon it. In the construction work test pressures as high as 1200 lb psi were specified.

The salient features of the service area are the boiler house, power station, water treatment plant, water circulating pumphouse and water cooling towers. There are four boilers, each with a capacity of 150,000 lb of steam an hour at a pressure of 500 psi. They are normally fired by oil, but gas can also be used. In addition to driving the three turbo-generators with a combined installed input of 18,750 kw, the steam is distributed through the refinery to the various process units at a pressure of 200 psi. Steam and power are also supplied to the adjoining plant of British Petroleum Chemicals, Ltd.

Sufficient electricity is generated to meet the entire power and light requirements of the refinery. All electrical apparatus in the installation is flameproof. The electric supply is distributed at 11,000 volts to several area substations each with a capacity of 2500 kva. Each is fed by three 1250 kva 11/3.3 kv transformers, two normally working and the third in reserve which is automatically brought into service in the event of a breakdown. Two 250 kva transformers are also available to supply 440 volts distribution from each section.

The large quantities of water required for cooling purposes are provided by two venturi reinforced-concrete cooling towers through each of which 1,500,000 imperial gal of water are circulated hourly.

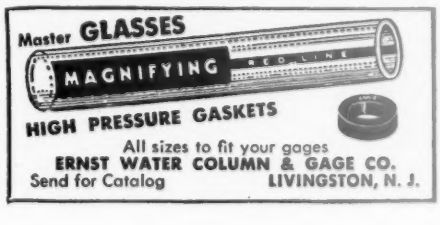
The distillation plant has a capacity in excess of 11,200,000 bbl a year. In the first two distillation towers light gasoline is drawn off and passed to the depropanizer and debutanizer towers, where propane and butane gases are removed. The feedstock next passes to the main distillation tower where benzine, naphtha, kerosine, light gas oil, heavy gas oil and residual fuel oil are separated. The light gasoline from the first two towers and benzine from the main tower are treated with caustic soda, sweetened with copper chloride and finally blended to give the correct octane rating for motor spirit. The naphtha, after receiving a similar soda wash, is used with the addition of a proportion of benzine, as feedstock for the chemical plant adjoining the refinery. A portion is also used in kerosine treatment.

Raw kerosine is first filtered through bauxite and later passes to the solvent extraction plant where it is mixed with liquid sulfur dioxide which separates the paraffins and the aromatics. The paraffins are treated with acid and soda and are refiltered through bauxite to produce paraffin oil and premium grade paraffin. The aromatics, after separation from the solvent, are redistilled and treated with plubite to produce a blending stock for tractor vaporizing oil.

The Grangemouth fluid cat cracker, a replica of those in operation at Landarcy and Kent, converts the heavier grade oils into motor fuels. In addition, it produces, a considerable quantity of gas that first passes through the Girbotol unit which removes its sulfur content. Then it is fed into the catalytic polymerization plant and processed into two products—high-octane motor fuel and tetramer, which is piped to the plant of British Petroleum Chemicals, Ltd., for use in the manufacture of petroleum-based chemicals. The sulfur extracted by the Girbotol unit is processed by the recovery section into flake sulfur, which is transported by road to Broxburn Oil Works where it is converted into sulfuric acid for use in the chemical industry. The sulfur recovery unit is currently producing 14 tons of the element a day. There is also a plant for the manufacture of white spirits.

Outlay on the first stage of development of the Grangemouth plant of British Petroleum Chemicals, (BPC)) Ltd., topped $14,000,000. Construction was organized and managed by AIOC with Stone & Webster Engineering Corporation, U.S.A., and its associates, E. B. Badger & Son, Ltd. (Great Britain) as principal contractors. This installation has an annual throughput of 660 million bbl of ethyl alcohol and isproply alcohol.

These alcohols are derived from ethylene and propylene respectively. The feedstock is naphtha derived from Middle East crude, and is procured



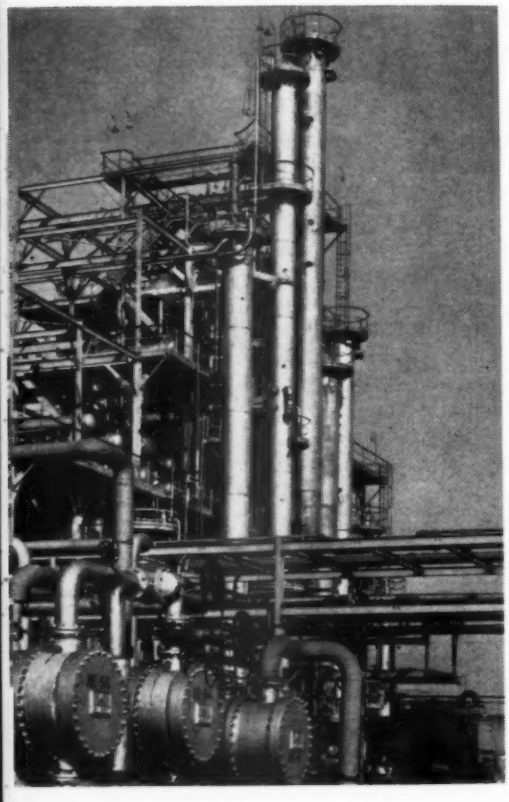
from the adjacent AIOC Grangemouth refinery. This is vaporized, mixed with steam and subjected to thermal cracking in a series of tubular furnaces. The ethyl alcohol process is that developed by Shell Development Company in the United States, and the isopropanol process is that evolved by the Distillers Company, Ltd., employing the absorption of propylene in sulfuric acid of the desired strength under carefully selected conditions. The rich acid liquid is then hydrolized by dilution with water, the crude alcohol is stripped from the acid, and finally purified by distillation. The company is extending the range of products manufactured at Grangemouth.

The plant of Forth Chemicals Ltd., formed in 1949, in which BPC holds a two-thirds interest and the British Monsanto concern one-third, was commissioned in early 1953, and reached full production (8000 long tons of monostyrene) in May of that year. Basic process designs for this unit came from Monsanto Chemical Company of the United States, while the ethylene feedstock for the plant emanated from the BPC cracking plant. The objective of this installation is to provide an indigenous source of raw material for the manufacture of polystyrene molding crystals. This plant is being further enlarged.

From the blending area of the Grangemouth refinery products are pumped to the tank farm occupying around 100 acres. Tanks for spirit and crude oil storage are fitted with floating roofs to prevent air from entering into the space between the liquid level and the tank top and forming a dangerous vapor. There are two hortonspheres for storing liquid gas under pressure. Dispatches are made by road or rail tank cars and by sea. There are 3½ miles of railway siding inside the refinery. The adjacent jetties, initially erected for the delivery of crude oil, are now utilized for outgoing traffic either by coastal tanker or by ocean-going vessels of 12,000 to 14,000 tons capacity.

A 12,340-ton (British Piper) tanker at the Finnart Oil dock, on the Scottish coast, sending crude to the refinery.

A British Petroleum Chemicals (BPCo. subsidiary) unit for gas separation with heat exchanger-coolers in foreground.



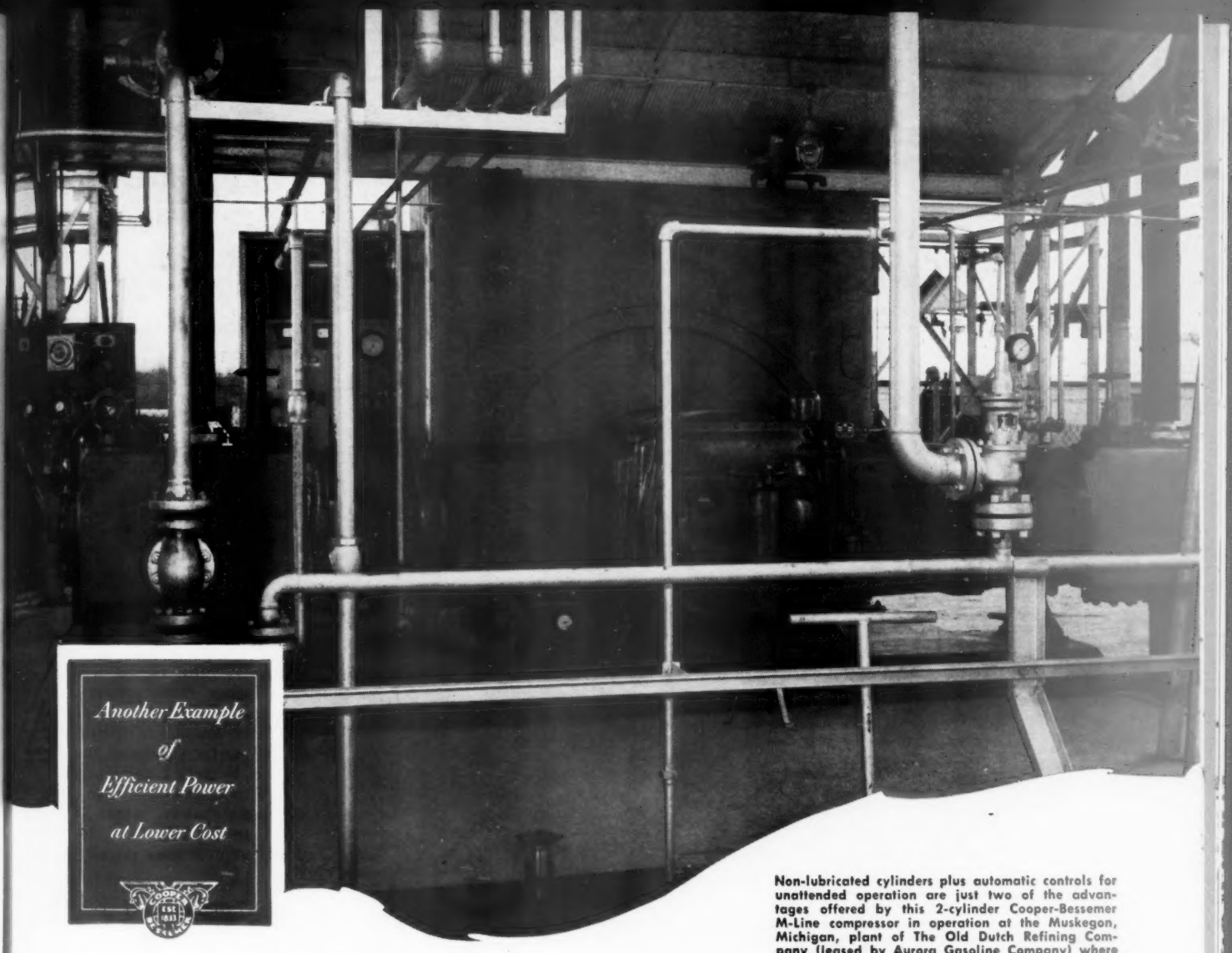
The site chosen for unloading crude oil is on the west coast at Finnart on Loch Long, where there is suitably deep water close off-shore. Work was started on the site in May, 1950, and the Finnart depot was operating by the following May. Here there are four large storage tanks into which crude oil is pumped from tankers before being dispatched to Grangemouth. In addition, there are two steam-heated tanks to store fuel oil and diesel oil to bunker outgoing ships.

The crude oil unloaded at Finnart reaches the Grangemouth refinery through a 57-mile long pipe line. This was laid across rocky and hilly terrain to avoid both built-up areas and alluvial soil whose fertility might be impaired by the weight of heavy equipment. This line runs under rivers, canals, railways, and roads. It is buried underground throughout its length. Corrosion is prevented by the use of bituminous mastic coating, and a cathodic protection system in which magnesium anodes buried with the pipe reverse the flow of electricity inherent in the corroding process.

The pipe itself is of steel, all-welded construction, tested to a pressure of 800 psi. Its internal diameter is 12.09 in. and it has a wall thickness of three-eighths of an inch. Since Middle East crudes contain wax that is deposited on the walls of the pipe through which they flow, the pipe line has to be cleaned regularly. This is done once or twice a year by a "go-devil" to which is attached a radioactive isotope. Thus, in the event of a stoppage of flow the exact location of the "go-devil" is detected by a Geiger counter.

Pumping crude through the pipe line is effected from Finnart by three ram pumps with a capacity of 560 bbl an hour, and by three centrifugal pumps each with a capacity of 420 bbl an hour. These are being replaced by electrically driven centrifugal pumps. The capacity of the line was recently stepped up by the installation of booster pumps. It went up from 16,800,000 to 22,750,000 bbl a year in mid-January, 1954.

The completed Grangemouth refinery proper, provides permanent employment for a staff of between 700 and 800. Modern well-equipped spray baths and locker rooms are provided, and recreation facilities include tennis courts, a bowling green, and a clubhouse. The original housing estate of 100 houses is being enlarged by the addition of 250 more. For those living farther away from the plant a special bus service is provided. * * *



Another Example of Efficient Power at Lower Cost

Non-lubricated cylinders plus automatic controls for unattended operation are just two of the advantages offered by this 2-cylinder Cooper-Bessemer M-Line compressor in operation at the Muskegon, Michigan, plant of The Old Dutch Refining Company (leased by Aurora Gasoline Company) where the UOP Platforming process is in use.

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RECYCLING millions of cubic feet of hydrogen a day for the UOP Platforming of low-octane gasoline, demands continuing efficiency from a smooth working compressor that will not contaminate the recycle hydrogen. That is one of the reasons why The Old Dutch Refining Company, leased by Aurora Gasoline Company, recently installed a 2-cyclinder Cooper-Bessemer FM compressor in their modern plant in Muskegon, Michigan.

To avoid contaminating hydrogen with oil in the recycle gas, Cooper-Bessemer successfully developed a non-lubricated compressor cylinder.

Operating against micro-smooth hardened cylinder liners, these 8" diameter carbon pistons require no lubrication whatever. With a mirror finish, the cylinder bores reveal no excessive wear.

No matter how exacting or complex your compressor problems, check the advantages offered by Cooper-Bessemer M-Line compressors. For dependability and money-saving operation, you can rely on Cooper-Bessemer — one of America's oldest engine builders offering the latest in engineering advancements.

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Synthesis of Petrochemicals —

Series Covering Conversion of Ethane, Propane, and Butanes to Petrochemicals to Begin in May

Peter W. Sherwood

The overshadowing importance of ethane-to-butanes in the production of the fabulous quantities of petrochemicals of all types will be shown comprehensively in a series of articles, starting in the May, 1955, Refining and Petrochemical Edition of *The Petroleum Engineer*. The economics and chemical synthesis of this host of products, the methods by which they are obtained and utilized, the commercial and industrial prospects for this amazing field, and the meticulous details of the main routines, processes, and their governing conditions will all be covered more exhaustively than has been the case in the history of any petroleum industry journal to date.

Reading and having available this series of articles will give the reader a condensed reference source that must be in the library of every plant operator, experimental chemist and engineer, every process supervisor in the industry. The same amount of first-hand information is not obtainable from any other source. The series is indispensable to all interested in petrochemicals, refining or in gas processing for any purpose.

The author, Peter W. Sherwood, is one of the leading chemical engineers and engineer-writers known in the industry and will cover this broad subject in a manner to make it understandable and useful. —Editor.

SHELL'S NEW CANADIAN SULFUR PLANT

Extensions to the Shell Petroleum Company's Jumping Pound, Alberta, Canada, plant, costing $500,000 have been completed, trebling the output of sulfur from natural gas. Plant's capacity is now estimated at about 28,000 tons annually. This extension matches the recent $1,500,000 expansion of its natural gas facilities in that area.

Since November, 1954, the plant has been producing 60,000,000 cu ft daily compared with a previous best of 35,000,000 daily.

Prior to the completion of this plant, Jumping Pounds' sulfur output was sold to pulp and paper manufacturers. But now a new and more vitally important outlet has been found. A substantial quantity of all sulfur produced there in the future will be railed and barged to the Gunnar Mines, Beaver Lodge, Lake Athabaska, Saskatchewan, where it will be converted to sulfuric acid for the processing of uranium ores mined there.

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TEMPERATURE OR PRESSURE

Mercoid DA-400 Series Controls are dual purpose controls (available for pressure or temperature) incorporating a single element operating two separate independently adjustable Mercoid magnetic mercury switches. Circuit arrangements can be supplied for various operations, a few examples are:

1. ***Close one alarm circuit at high setting and a separate circuit at low setting. Both circuits remain open between the high and low operating points of the two switches.***
2. ***As an electrical interlock to open one circuit on a rise above, and the second circuit on a drop below the set operating point.***
3. ***To provide two-stage control by opening one circuit on a rise and a second circuit on a further rise.***

Pressure types **available in 17 different operating ranges from 0-30" vac. to 300-2500 psi.** ***Temperature types*** **available in 11 operating ranges from -30-60°F. to 370-530°F.**

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FOR EVERY APPLICATION

BRONZE, IRON, STEEL, STAINLESS STEEL

FIG. 29 Cylinder with Impeller

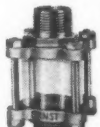

FIG. 17-28 Cylinder

FIG. 215 Flanged

FIG. E-57 Double Window

FIG. 212 Visibility Welding Neck or Screw

FIG. E-811 Flapper

FIG. E-1810 Rotating Wheel Type

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ERNST WATER COLUMN & GAGE CO.

LIVINGSTON, N. J.

Airplane view of Altona refinery in October, 1954 P 701.

La-ge alkylation unit among expanded facilities of this growing plant

ALTONA, AUSTRALIA, REFINERY ON STREAM

V. S. Swaminathan

AUSTRALIA is experiencing her largest refinery expansion in history. In 1953, she met only 15 per cent of her national needs; by 1956 she will be producing nearly 80 per cent. In this year, Australia has projected its domestic refinery production at 6,646,-000 long tons and consumption, 7,900,000.

In meeting this demand several companies are in the process of rapid expansion. Vacuum Oil Company, Pty., Ltd., Standard-Vacuum Oil Company's principal marketing affiliate in Australia, has been a pioneer. Vacuum is nearing completion of several units at its Altona refinery. Addition of the key alkylation unit will have an annual output of 20 million imperial gallons of high octane number aviation gasoline.

Domestic processing of crude results in growth of Australia's economy. Savings in foreign exchange from the addition of this one alkylation unit is $3,600,000.

Expansion has been phenomenal at the Altona refinery. The plant, commissioned in July, 1949, has capacity to meet the relatively restricted market for lube oils and asphalts. Capacity was set at 1300 bbl per stream day. In due course, it was stepped up to 2500 bbl per stream day.

Prior to the start-up of the local installation, low viscosity index lube oils and asphalt were imported from California.

Three years from the opening date, it was decided to extend the facilities for the production of high grade gasoline and fuel oil, which included a 25,-000 bbl per stream day crude distillation unit of conventional design and the standard 7500 Thermofor catalytic cracking unit with a total feed capacity of 19,000 bbl per day. These new facilities were expected to go on stream December 10, 1954, slightly ahead of schedule.

The original plant consisted of a combination crude unit producing light naphtha, diesel fuel oil, three grades of once-run lube distillates and several grades of asphalt. The once-run distillates were run in the presence of caustic soda and bright marketable lube oils in three different viscosities were taken from the side stream.

This unit was operated to give minimum bottoms containing all the caustic soda, the material being a mixture of 40 per cent soap and 60 per cent hydrogen. This soap was broken in a deashing agitator and the deashed re-run bottoms were utilized as boiler fuel. The lube oils were blended to give a considerable number of viscosity specifications and shipped to all parts of Australia and New Zealand in 45-gal steel drums.

Asphalt was delivered both in drums and in bulk in insulated road wagons taking hot asphalt direct to the road building site. For greater distances hot asphalt was transported in rail tank cars. The road wagons were found to have a highly economic operating radius up to 120 miles.

The Altona property embraces 300 acres on a level site some 5 miles from the deep water port at Williamstown and nearly the same distance from the marketing company's bulk distribution installations. It was found convenient to reconstruct one of the docks at Williamstown port and erect some transit tankage adjoining the dock to hasten the rapid unloading of tankers. In this sector two 120,000 bbl floating roof tanks were built to receive the crude oil, which is pumped to the refinery crude storage tanks 5 miles away through an 18-in. line. These facilities permit tankers to be discharged at the rate of 7000 bbl per hr and it is planned to use super-tankers to feed Altona with crude.

Process design of the enlarged facili-

EXCLUSIVE

ties was undertaken by the refinery engineering division of Socony-Vacuum. Contract for the mechanical design and construction of the entire plant was let to C. F. Braun and Company of Alhambra, California. Braun set up a separate company registered outside the United States, designated Braun Transworld Corporation, to handle this job.

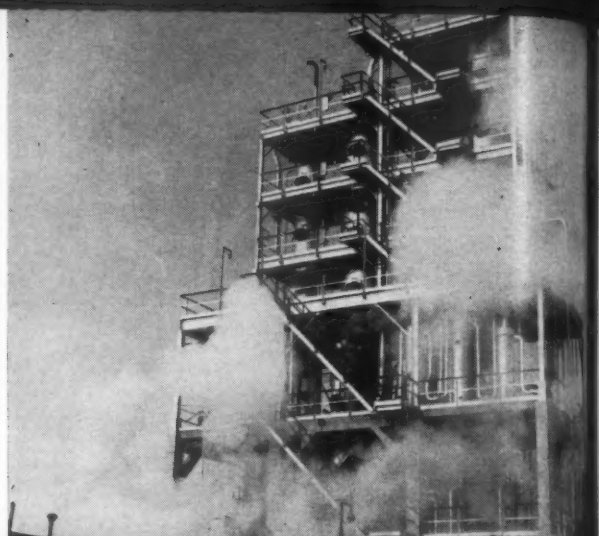
The Altona plant consists of a 25,000 bbl per stream day crude distillation unit of conventional design. There is also a naphtha splitter tower to divide into light and heavy fractions. The lighter naphtha is used in the blending pool and the heavy naphtha as catalytic reformer feed. The crude unit produces the required quantities of automatic diesel oil and all heavier fractions go to feed the TCC unit, with a feed capacity of 19,000 bbl per day.

The TCC unit is the first of its kind to be built in Australia. Since the end of World War II, Socony-Vacuum has been perfecting its new air-lift TCC unit, which gets its name from the fact that the regenerated catalyst is blown by air through a pipe more than 200 ft high to the top of the reactor. The catalyst then flows from the top of the pipe by gravity. Air replaces the mechanical methods of catalyst raising employed in earlier designs. The new unit possesses the advantage of easier and simpler operation, combined with greater flexibility, enabling a wider range of stocks to be handled. The latest air-lift TCC unit increases both the quantity and quality of petroleum products, in particular motor fuel.

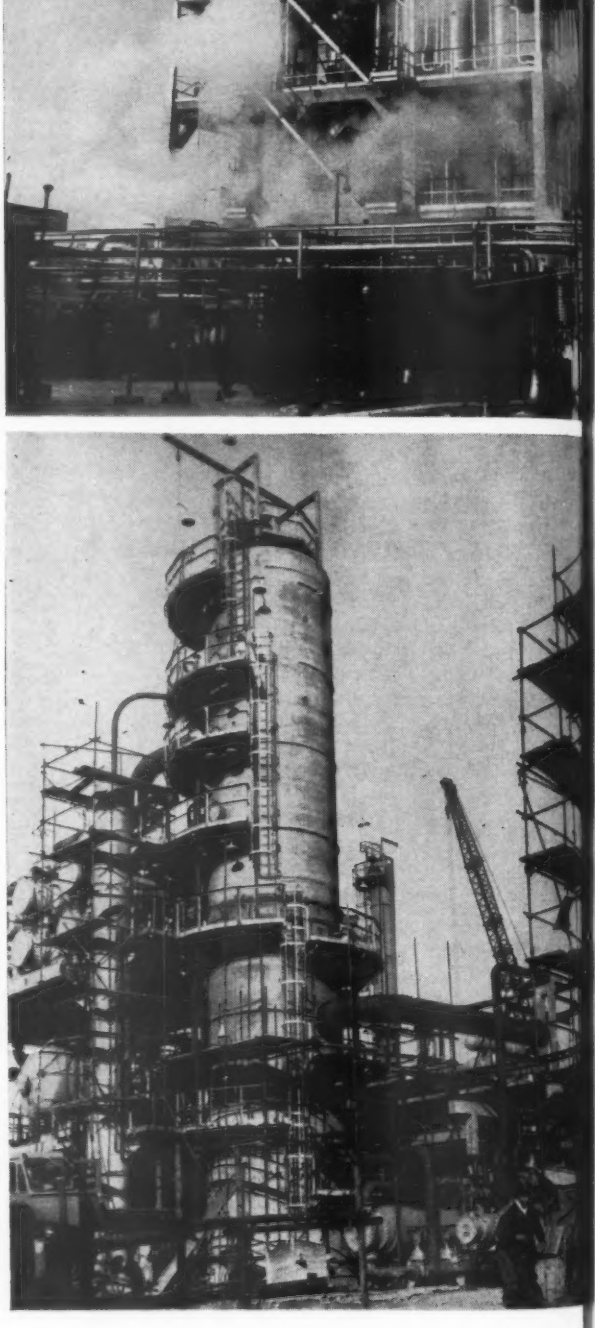
Heavy oil from the crude distillation unit goes first to the TCC feed preparation unit consisting of a tar separator and vacuum jug, tar from the former forming the feedstock of the latter. This TCC unit takes both vapor and liquid feed. Vapor from the tar separators passes direct to the TCC reactor, while the liquid feed is taken from the vacuum jug. The vacuum jug bottoms go to heavy fuel oil or are worked up into asphalt. The TCC unit makes gas, gasoline, diesel fuel oil, and heavy fuel oil. Gas is compressed by a single centrifugal compressor driven by a turbine. Gas and gasoline are treated in conventional absorber and stabilizer towers.

Part of the gas is used as refinery fuel and a large block of it is being sold to the local Gas and Fuel Corporation. It is blended with domestic gas manufactured by the latter corporation from brown coal by means of a Lurgi plant erected at Yallourn, 90 miles from Melbourne. This gas is piped to Melbourne and blended with the refinery gas to improve its calorific value. Vacuum has built a gas desulfurization unit that will also dehydrate the refinery gas before it passes to the Gas and Fuel Corporation pipe line. This unit employs monoethanolamine and diethylene glycol. Equipment for the sale of gas includes a well equipped gas laboratory to keep control of quantities and qualities delivered to the local Gas and Fuel Corporation.

Gasoline from the distillation and TCC units is treated in a conventional solutizer plant for control of corrosive sulfur and thence sent to the blending department. This consists of a series of tanks and a modern ethyl blending unit for control of specifications. The crude distillation unit also produces jet fuel. There is a copper chloride sweetening unit in the light oil treating area for its treatment. Three 6-in. pipe lines convey products to the marketing company's bulk distribution plant installa-



No. 1 crude unit, heart of the old refinery operations



"Synthetic crude" tower, handling distillate from cracking unit

tion located some five miles away. They are to be used for carrying heavy fuel oil, middle distillates and gasoline products respectively.

The Altona distillation and cracking plant with an annual capacity of 7,500,000 bbl yields the following products per day: motor fuel, 10,000 bbl; lighting kerosine 1400 bbl; power kerosine 1000 bbl; diesel fuel 1500 bbl; and bunker fuel 300 bbl.

The cooling water arrangement for the Altona plant was originally designed as an "all loss" system, salt water being pumped from a nearby creek. With installation of the expanded facilities this system had been changed into a totally enclosed one. A 5-cell Marley cooling tower has been constructed.

Off-site facilities have been extended appreciably to meet the requirements of the enlarged installation. The power plant has been extended by the addition of two 70,000-lb Riley boilers; new machine shops and a warehouse store have been constructed. There is a new administration block of offices and a new cafeteria and auditorium for the staff. There is a new well-equipped laboratory and a new change house and locker room for workers.

Crude oil from the old refinery was initially drawn from Venezuela. Early in 1950 suitable crude was obtained from the new Klamono field in northwestern New Guinea, a very much closer source of supply. Crudes for the enlarged plant are being drawn from the Persian Gulf and another new field, Wasian Mogoi, also in northwestern New Guinea. These are stored separately and blended in the feed line to the distillation unit.

Further additions to the refinery already decided upon are a sulfuric and alkylation unit and a Sovaformer (catalytic reformer). Engineering on the latter unit has been completed and construction will begin in early 1955. Engineering on the alkylation unit is now under way. Plans for the additional refining equipment are well advanced and the construction job is to start soon. The 15,000 tons of sulfuric acid required to operate the plant would come from the plant of the Commonwealth Fertilizers and Chemicals, Ltd. The new unit is scheduled to go on stream by mid-1956.

Other companies are contributing to the sharp increase in refined products, other than Vacuum. Shell operates the Geelong and Clyde plants. The Kwinana refinery of the AIOC in Western Australia was commissioned early this year. Caltex Oil of Australia, Ltd. has a refinery at Kurnell, and the Bitumen and Oil Refineries Ltd. plant has been located at Botany Bay, adjoining Sydney. * * *

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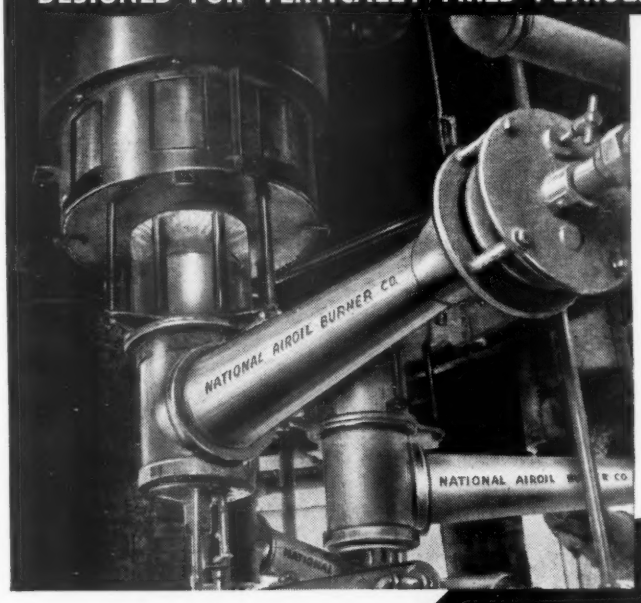

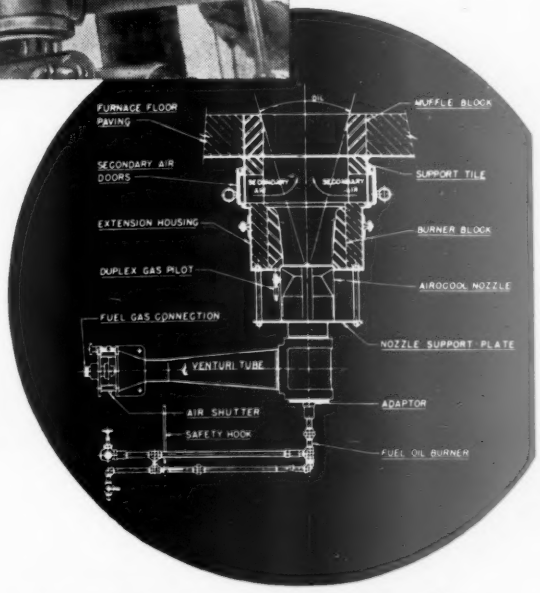

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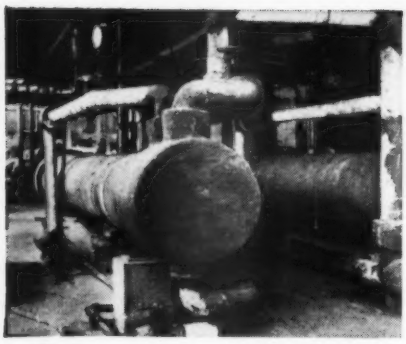
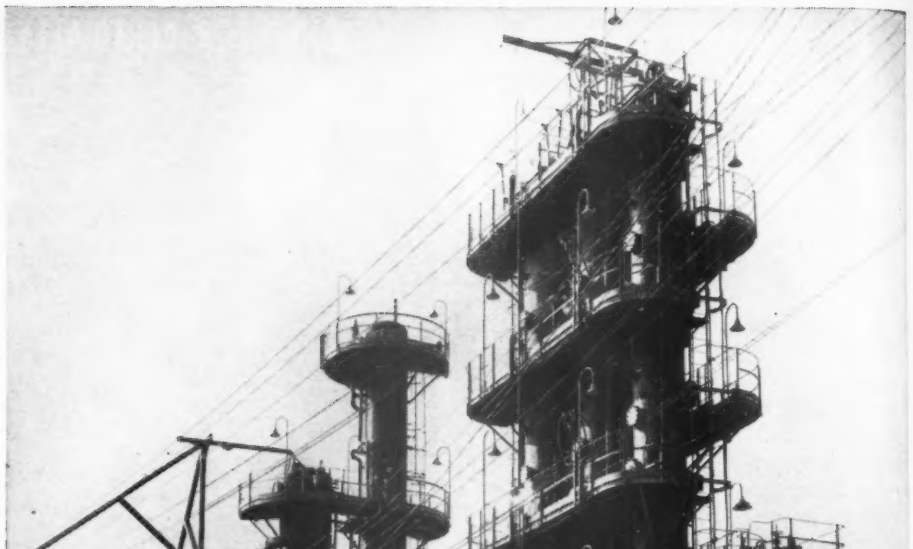


Heat Exchange between pure caustic leaving the Unisol process regenerating tower and contaminated caustic entering, is accomplished in this all-Monel preheater.

Mercaptans are Steam-Stripped from Methanol-Caustic Soda Solution in this Unisol process regenerator tower at Atlantic Refining Company's Philadelphia refinery. Monel construction protects the tower, piping, preheater and reboiler from the extreme corrosiveness of the hot caustic solution.



When it's a question of caustic corrosion . . . refiners find Monel effective

Wax is Washed Free of Caustic with hot water in these agitator tanks at Atlantic Refining. Coned bottoms and sides to a height of six ft. are lined with Monel to withstand caustic corrosion.

Wherever caustic soda is used in hot or concentrated solutions, it is apt to create corrosion problems. Two such places in the refinery are:

1. Caustic regeneration in mercaptan removal processes.
2. Lube oil and wax treatment.

In both processes, Monel is widely used for equipment that must stand up under corrosion by hot caustic solutions.

In caustic regeneration, you find Monel used for the regenerating towers, and for pumps, piping, preheaters and reboilers. For parts where temperatures may reach or exceed 500°F., as in evaporator tubes, Inconel is to be preferred for its superior resistance to sulfide-containing caustics.

In the large outdoor agitators where hot wax is allowed to settle, then washed free of excess caustic left after neutralization processes, Monel linings have proven to be a satisfactory solution to the corrosion problem. Both nickel and Monel equipment are used to store caustic solutions. "S" Monel, with its excellent anti-galling properties is combined with Monel in hard-to-lubricate pumps to prevent seizing.

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200,000 barrels of crude capacity per day in British Isles alone; eleven refineries on continent

huge REFINERY EXPANSION IN EUROPE

V. S. Swaminathan*

THE Royal Dutch Shell Company was registered on June 16, 1890. Its close cooperation with The "Shell" Transport & Trading Company, Ltd., London, led in 1907 to the famous alliance which to the present day has remained the basis of the Royal Dutch-Shell Group. Since then Royal Dutch and Shell have worked together in harmony, set up hundreds of companies in virtually every country in the world, either for marketing, exploration, production, refining, transport, or research, and have continued to share good or ill fortune in the original ratio of 60:40; much good, but also some ill fortune.

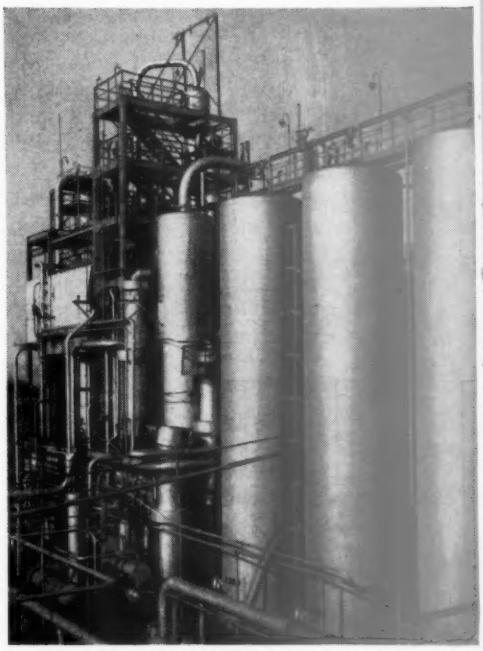
In the years 1907-10 The Royal Dutch-Shell Group's production fluctuated between one and two million metric tons when world output ranged between 35 and 45 million tons. In 1930 the group accounted for 24 million metric tons, against 200 million tons for the whole world. In 1953, while world production totalled 5020.8 million barrels, the group's share was 616.8 million barrels. Before the second World War the group was not enthusiastic about erecting refineries in centers of consumption far removed from those of crude oil production in the Eastern Hemisphere.

For various reasons this policy underwent a radical change, and one now finds the Royal Dutch-Shell Group one of the foremost refiners in Western Europe, including the United Kingdom. It also accounts for a small output of crude products in Europe. In 1953 its production of crude petroleum and natural gasoline amounted to 4,200,000 bbl (3,700,000 bbl in 1952)—the leading producers being the Netherlands with 2,900,000 bbl, Western Germany with 900,000 bbl, and Austria with 400,000 bbl. The group and associated companies processed a global total of 626,000,000 bbl of crude oil and natural gasoline in 1953, equivalent to a daily average rate of 1,700,000 bbl, in addition, 11,000,000 bbl were blended direct into finished products. The amount of crude oil processed in the group's Western European refineries was 159,000,000 bbl in 1953.

Since the cessation of armed hostilities in Europe, the group embarked on a major two-purpose expansion program. Apart from the new construction and extensive repair and rehabili-

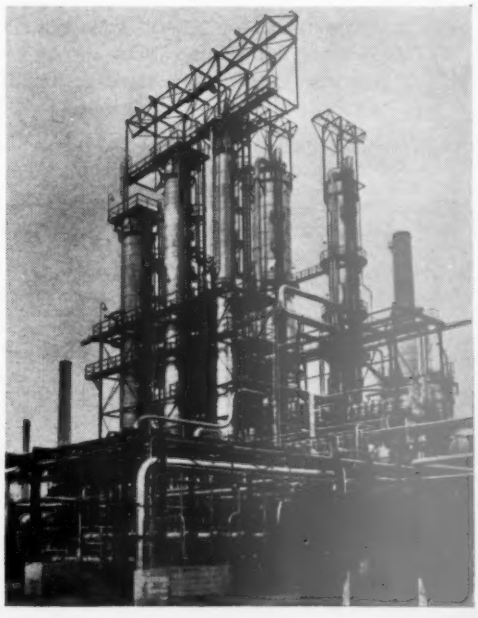
*European Correspondent.

EXCLUSIVE

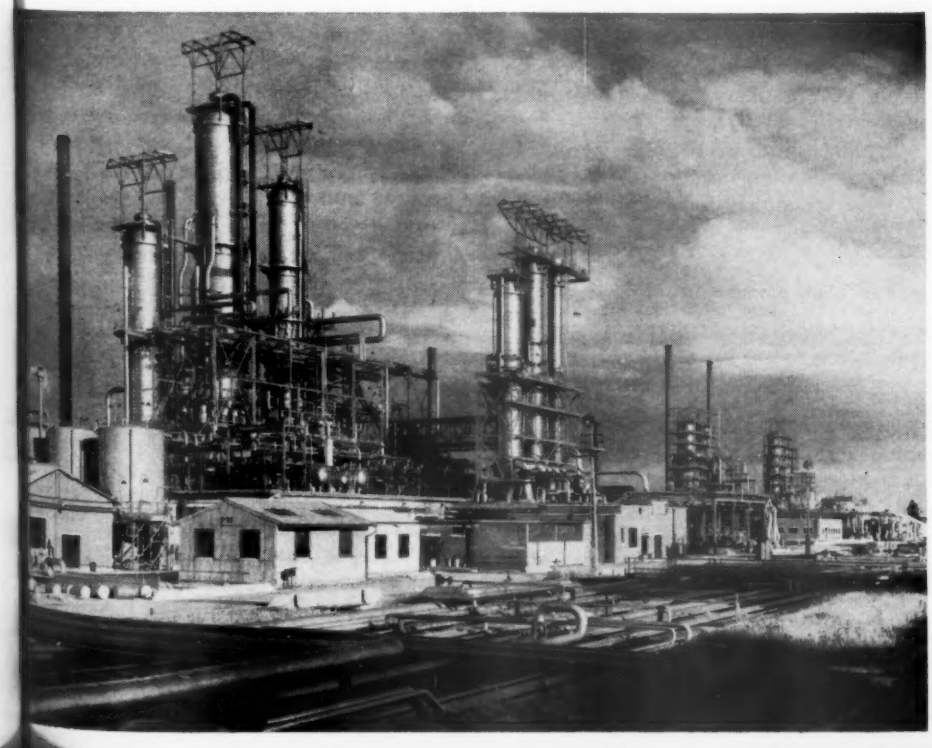


▲ Shell Haven Refinery, England, columns constitute rotating disc contactor unit for lubricating oil refining

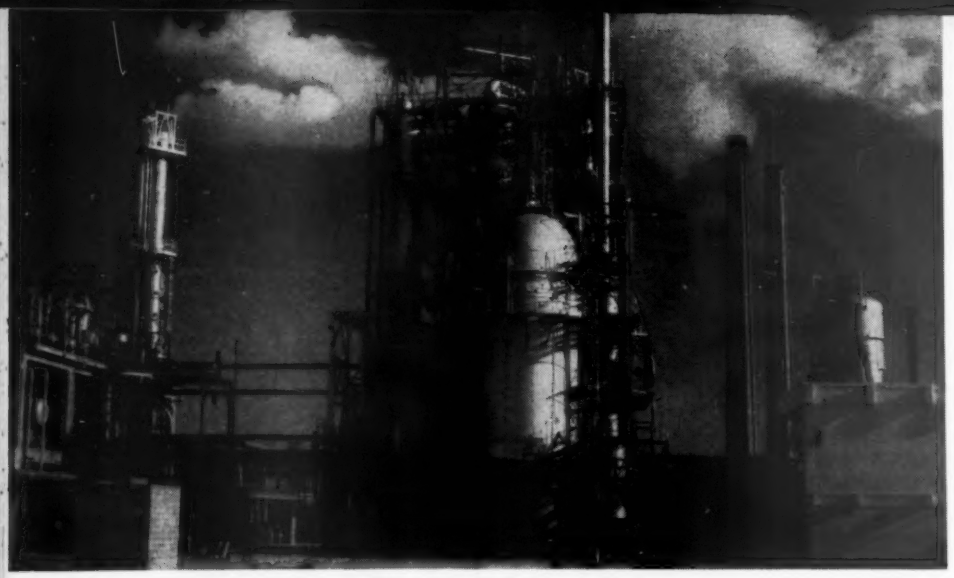
▼ Crude distillation unit (40,000-bbl per-day) at Pernis, Holland, refinery



General view of distillation units, No. 1 at right, feed preparation center, and No. 2 at left, Shell's Stanlow, England, refinery



XUM



Fluid catalytic cracking unit at the Berre-L'Etang, France, refinery

tation of all the war-damaged installations, this plan entailed substantial addition to crude distillation capacity, and entry into the petrochemical field, based largely on crude oil imported from the Middle East.

Certainly, the UK refinery construction and expansion program, in particular that of Stanlow in Cheshire, England, holds pride of place. The crude distilling capacity of the group's British refineries in mid-1954 was 196,800 bbl per day, with the Stanlow plant accounting for 91,000 bbl per day.

The Shell Stanlow installation was the first in the country to install a fluid cat cracker (28,000 bbl per day), pioneer in recovering elemental sulfur from refinery gases, the first to erect a Platformer and an iso-pentane unit and the first in the world to construct a 5500-bbl-per-day hydrodesulfurization plant, based on the "Trickle process" perfected by the BPM laboratories in Amsterdam. It also pioneered the quantity production of the synthetic detergent "Teepol," and the manufacture of petroleum-derived solvents in Britain. The refinery proper and the petrochemicals plant adjoin the Thornton Research Center, focusing the group's research and development activities in the United Kingdom.

Starting in 1922 as a tankage installation from which finished products from foreign refineries were redistributed through Britain, Stanlow has grown, since the second World War, into one of the largest integrated refineries in the Eastern Hemisphere, manufacturing from imported Middle East crudes, hundreds of different items ranging from bottled gas, chemical solvents, gasoline, diesel oil, lube oil, and fuel oil to bitumen.

The refinery site covers an area of 2000 acres, of which nearly two-thirds is occupied by plants, tank farms, and distribution facilities. Approximately 16½ miles of road, 14½ miles of rail and more than 700 miles of pipe line provide communication within the refinery. The plant calls for 3,000,000 tons of water a year for high-pressure steam, and 90,000,000 kw of electricity. Its intake of crude oil and other feedstocks amounts to 15,000 tons daily. The height of the main water cooling tower is 341 ft; the diameter of the pond of this tower is 270 ft, and its rating is five million gal per hour. Refinery operations are continuous. Bulk movements of crude oil products to and from tankers take place at rates up to 2000 tons an hour.

Britain's first iso-pentane plant at Stanlow, entailing an outlay of $1,400,000, is scheduled for completion in early 1955. The main contractor is Head Wrightson Ltd., and this installation is calculated to contribute handsomely to the versitility of the refining system here and is complementary to the Platformer which went on stream late in 1954.

In the iso-pentane unit the debutanized light platformate is led through a steam pre-heater to the depentanizer —an 86-ft column containing conventional bubble-cap trays, where the pentanes are removed as a top product. The bottom stream — depentanized light formate—is run down to avaition component storage. The de-iso-pentanizer —a 200-ft column, containing 140 Turbo-grid trays — receives two streams, via steam heaters, i.e. the pentane fraction produced above the debutanized straight-run gasoline, and yields iso-pentane as the overhead stream. The bottom product comprising de-iso-pentanized straight-run gasoline plus the normal pentanes from the platformate are blended into motor fuel. A sphere is being provided for storing iso-pentane.

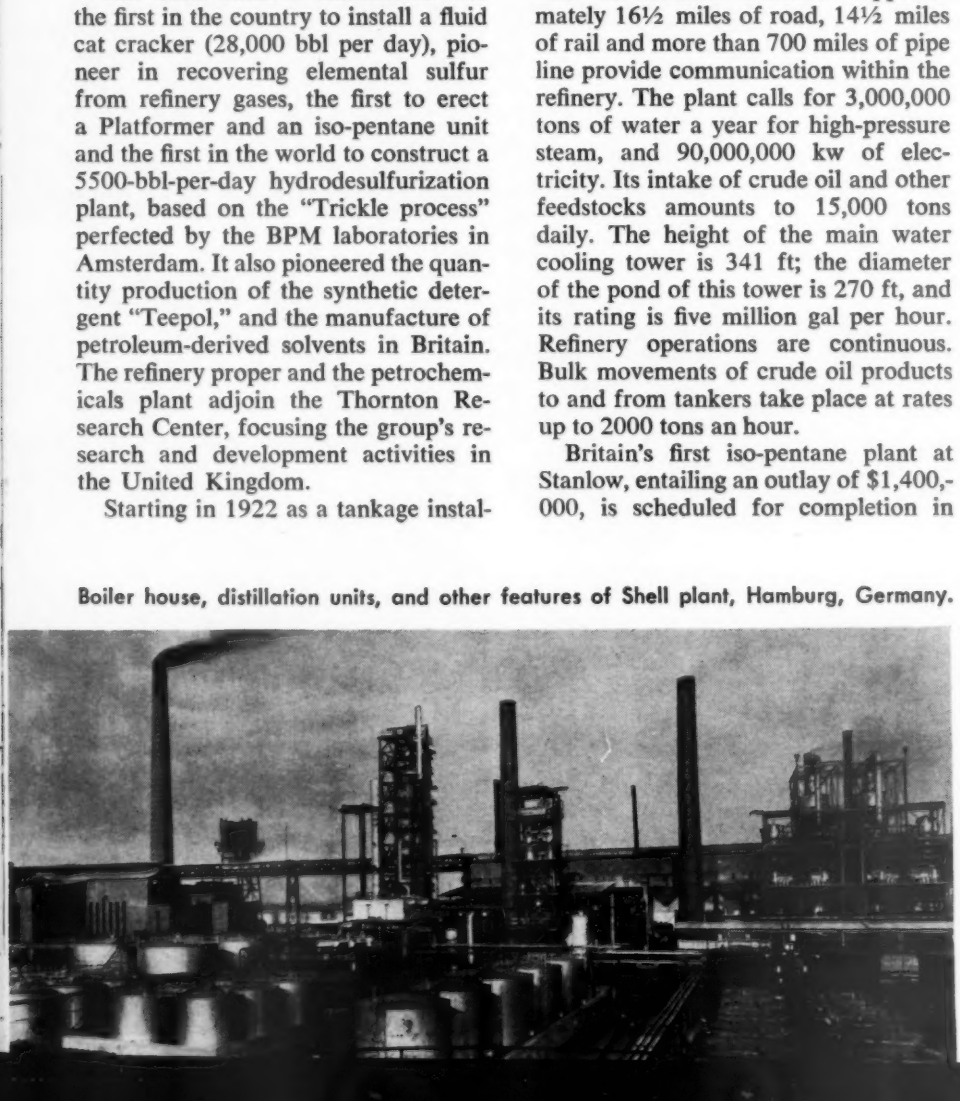
Heat for the process is provided by steam at low pressure for pre-heaters, and high pressure for re-boilers. The de-iso-pentanizer operates at 25 psi, and the column concerned is believed to be the tallest in the world. The world's premier hydrodesulfurization unit was slated to start operation at Stanlow early this year, also the Chemico low temperature H_2SO_4 sludge decomposer unit.

The Shell Haven refinery, the second largest owned and operated by the group, meets the petroleum product needs of the southern half of England. It specializes in the manufacture of certain types of lube oils, and has the highest output of aviation jet fuel of Shell refineries in Britain. Set in the marshland on the northern bank of the Thames, a few miles east of Tilbury, units of this refinery are grouped on either side of the London & Thames Haven Wharves Ltd., where tankers can discharge crudes into tank storage farms. It enjoys excellent facilities for getting finished products to the consumer by road, rail, and water.

Shell started operating here as early as 1916 with a single distillation unit on an 100-acre site. Today, the Shell Haven refinery covers an area of 350 acres, with another 650 acres at hand for future development. Its crude distillation capacity is 66,000 bbl per day, and reforming capacity 9200 bbl per day. Current crude intake is 50,800 bbl per day and imported feedstocks intake 8100 bbl per day. The 6700 bbl per day Platformer is to be completed in late 1955.

This refinery makes use of 1,000,000

Boiler house, distillation units, and other features of Shell plant, Hamburg, Germany.



tons of steam and 36,000,000 units of electricity every year. Cooling water is pumped to the plants from the Thames through a 9-ft tunnel by pumps with capacity to deliver three million gallons per hour. The refinery area has 11 miles of road, 6 miles of railway and 500 miles of pipe line, and its construction called for 180,000 tons of steel, 6000 tons of cement, 8000 concrete piles and 5,000,000 bricks. It handles 42,000 road-and-rail-tank cars every year; employs 2000 people and has its own complete and up-to-date fire service.

The Heysham (Lancashire) plant was first mooted in 1939 with the formation of the trinity, Trimpell (Trinidad Leaseholds, Imperial Chemicals and Shell). In 1948, with the waxing need for petroleum products, entailing a minimum outlay of dollars, Shell started revamping and reconstructing this installation. The refinery's crude distillation capacity is 36,000 bbl per day, visbreaking capacity 6100 bbl per day, and reforming capacity 4100 bbl per day, while crude intake is of the order of 27,500 bbl per day.

At Ardrossan, in Scotland, Shell operates an asphalt plant, with crude distillation capacity of 3200 bbl per day. Its crude intake is 2500 bbl per day and intake of imported feedstocks, 1000 bbl per day.

With a crude distilling capacity of 200,000 bbl per day, the Shell Pernis refinery at Rotterdam is the largest in Europe. Initial construction of the installation on the present site on the south bank of the Nienwe Waterweg was started in 1937 and completed two years later. At that time the refinery included a crude distillation unit with atmospheric and hydrogenation. In 1939 its crude throughput was only a tenth the current total.

During the second World War this refinery sustained severe damage and its operations were at a standstilll. Following the cessation of hostilities an extensive program of rehabilitation and expansion was undertaken by the company. Today, in addition to the four distillation units this complex embraces such facilities as thermal cracking and reforming, a 29,250 bbl per day fluid cat cracker (the first of its kind to be commissioned in Europe), polymerization, lubricating oil and bitumen units, as well as treating facilities. In 1953, for the first time, refinery gases from the Pernis refinery were sold to the Rotterdam Municipality.

As at Stanlow in Britain, petrochemicals play an important part at the Pernis refinery. There are units for manufacturing synthetic detergents, polyvinyl chloride plastics, "Epikote" resins employed in the paint and varnish industry, elemental sulfur, chemical solvents, and the two new insecticides—dieldrin and aldrin. The insecticides installation (capacity 3000 tons) was commissioned in October; and the 12,000 bbl per day deasphalting unit completed in the fall; while the addition of 1750 bbl per day to the lubricating oil section is expected to go on stream in early 1955. A second fluid cat cracker of 33,000 bbl per day capacity is under way duplicating the existing one to balance distillation capacity at the refinery, and is to be commissioned in 1956.

The total area of Pernis is 900 acres, of which 500 are in use for processing and kindred facilities. Its aggregate water front, including tank farms, covers 3.5 miles. There are 19 docks for tankers, coastal vessels, and lighters. Seven tankers, including 28,000-tonners, can berth at the same time.

At Ghent in Belgium, Shell operates a lubricating oil and asphalt unit with a crude distilling capacity of 3000 bbl per day. It processes imported topped asphaltic crude and produces straight-run and blown bitumens, lubricating oils, special mineral spirits and grease. Crude intake in mid-1954 was 1600 bbl per day, and imported feedstock intake, 100 bbl per day.

Through its majority interest in Shell Berre the group operates three refineries in France in conjunction with Compaignie des Produits Chimiques de St. Gobain, namely Petit Couronne, on the banks of the Seine near Rouen; Berre l'Etang on the shore of the Etang de Berre adjoining Marseilles, and Pauillac on the Gironde, 30 miles northwest of Bordeau.

Petit Couronne was commissioned in 1929 to process 1800 bbl per day, this capacity was stepped up to 12,750 bbl per day by 1938. It sustained war damage, and following rehabilitation and expansion, the current distilling capacity is 50,000 bbl per day (thermal cracking 5000 bbl per day, used according to needs as crude distilling unit, gasoline reformer or cracker, and reforming, 3500 bbl per day). An 8000 bbl per day fluid cat cracker is scheduled for commissioning by mid-1956.

Here Middle East crudes are processed for straight-run gasoline, reforming naphtha, kerosine, gas oil and a straight-run residual fuel. The essentially South American asphaltic crudes are distilled in an atmospheric unit for the production of gasoline, tractor fuel, and gas oil. The atmospheric residue is vacuum-distilled for gas oil, a straight-run distillate and a range of bitumen residues. The straight-run distillate is refined to produce conventional L-V-I lubricating oils. The synthetic detergent ("Teepol") plant was commis-

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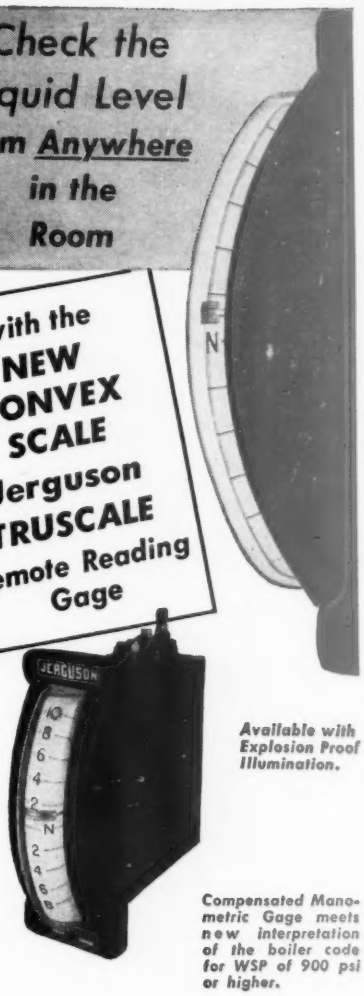

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TABLE 1

Location	Type	Crude distilling capacity	Cracking Thermal	Capacity Catalytic	Reforming capacity	Current crude intake
		(All figures in U.S. barrels daily)				
Argentine:—[1]						
Buenos Aires	D/C/Ref	18,000	9,000	—	3,000.	17,100
Australia:—						
Clyde	D/Lube/A	8,400	—	—	—	8,900
Geelong	D	36,000	—	[2]	—	29,800
Egypt:—						
Suez	D/C/A	40,000	6,400	—	—	36,000
Indonesia:—						
Balik Papan	D/Wax	50,000	—	—	—	49,000
Pladju	D/C/Ref	85,200	10,000	—	15,000[3]	83,600
Tjepu	D	4,600	—	—	—	4,100
Wonokromo	D/A	3,200	—	—	—	2,900
Netherlands Antilles:—						
Curacao	D/C/Ref/Lube/A	200,000	100,000	—	18,000	307,600[4]
Sarawak:—						
Lutong	D	47,300	—	—	—	47,400
Trinidad:—						
Point Fortin	D/A	30,000	—	—	—	26,900
Venezuela:—						
Cardon	D/C/Ref/Lube	145,000	25,000	—	8,500	168,600[5]
San Lorenzo	D	45,000	—	—	—	45,900

(1) A 500 b/d Lube oil refinery planned for completion in early 1955.
(2) A 12,000 b/d cat cracker to be completed in mid-1955.
(3) Of this 7500 b/d represents idle reforming unit being revamped for crude distillation to start toward end of 1954.
(4) Includes crude intake to cracking plants.
(5) Includes crude intake to cracking plants.

A=Asphalt
C=Cracking
D=Distilling
Lub=Lube oil.
Ref=Reforming.

sioned in October, 1951, with a designed capacity of 25,000 tons per annum, and it has undergone considerable expansion since.

The Berre l'Etang refinery came on stream in 1931 with a throughput of 1000 bbl per day, taken up to 10,000 bbl per day in 1938 and further stepped up to 63,000 bbl per day in the summer of 1951 by the addition of a new crude distillation unit. The enlarged installation now has a crude distilling capacity of 70,000 bbl per day (cat cracking 8000 bbl per day and reforming, 9000 bbl per day. Its crude intake is 72,000 bbl per day and imported feedstock intake, 500 bbl per day. A petrochemical plant, accounting annually for 7500 tons of acetone and other solvents, was added in 1953. It obtains its propylene from the adjoining Shell Berre refinery.

The Pauillac installation, with a prewar capacity of 13,500 bbl per day, was totally destroyed by Allied bombing during the emergency. Today its capacity is 12,000 bbl per day, and crude intake 9200 bbl per day.

Turning to West Germany, the Harburg refinery of Deutsche Shell was totally destroyed during the last war, and the reconstructed new installation, commissioned in November, 1949, has a crude distilling capacity of 10,000 bbl per day and accounts for gasoline, gas oil, lube oil factions and bitumen from Middle East crudes. Grasbrook forms the production center for grease, lube oil blending, production of transformer, cable and other highly refined lube oil fractions, employing gasoline fractions from Harburg and special mineral spirits fractionated and treated in Wilhemsburg. The Monheim-Reisholz plant has 4000 bbl per day distilling capacity and produces refined products, including lube oils and asphalt.

A new company, Rheinische Olefinwerke Gm b H., was set up in early 1954 by BASF and Deutsche Shell at Wesseling. It is erecting a plant for the production of polyethylene and ethyl benzrene based on refinery gases from the Wesseling refinery. This unit is scheduled to start production in 1955.

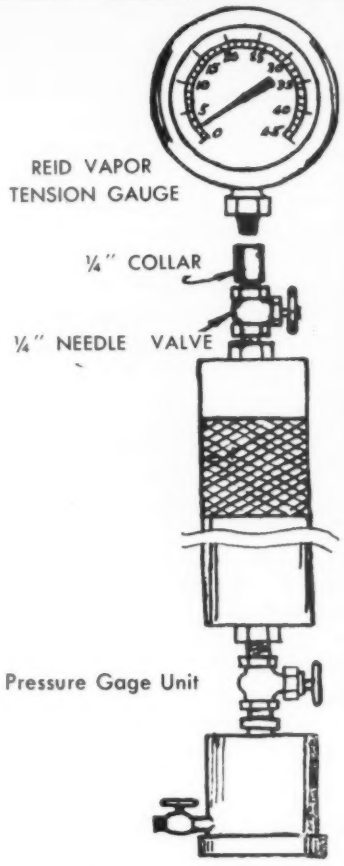
The crude distilling capacity of the group's refinery at La Spezia near Genoa in Italy has been stepped up from 17,000 bbl per day to 30,000 bbl per day. Its reforming capacity is 2800 bbl per day, crude intake 26,900 bbl per day and that of important feedstocks 2100 bbl per day. This plant produces gasoline, special mineral spirits, kerosine, gas oil, and fuel oils. There is a small thermal reformer for octane improvement. Rivarolo adjoining Genoa is the group's center for producing transformer oil, white oils, and greases.

In Austria Shell's 3400 bbl per day Floridsdorf refinery accounts for the essential range of petroleum products including lube oils and asphalt. Its crude intake is 2100 bbl per day.

Leaving Europe (including UK) and exclusive of the United States and Canada, this global group's refining activities as of June 30, 1954, are assembled in Table 1.

In 1953, Shell's U.S. refineries had a throughput of 164,000,000 bbl and those of Canada, 15,000,000 bbl. In conclusion, Burmah-Shell Refineries Ltd. is erecting a comprehensive 40,000 bbl per day refinery at Bombay, India, which is scheduled for completion in the second quarter of 1955. * * *

PLANT AID



Vapor Pressure Gage Saver†

DON ATTAWAY*

The ASTM Code requirements for conducting a test for vapor pressure of natural gasoline calls for the vigorous shaking of the bomb at 2 min intervals for as long as 20 min. This severe and violent shaking causes the pressure gage to fluctuate widely thereby subjecting the hair spring and linkage to excessive abuse and wear thus shortening the life of the gage and impairing its accuracy.

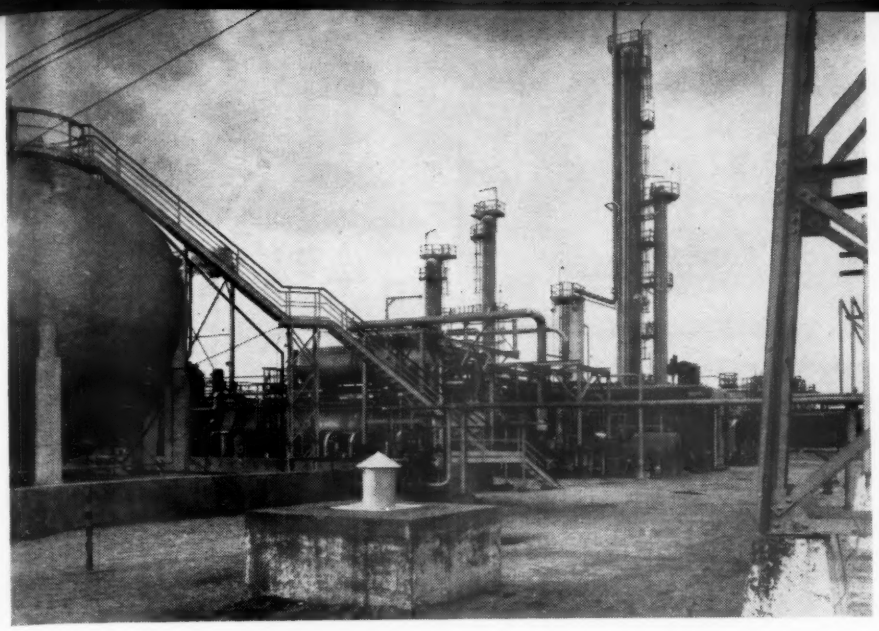
It is proposed that a needle valve and collar be installed on the top oulet of the air chamber and the bomb and sample chamber be assembled for the primary portion of the test without attaching the pressure gage.

The test is then conducted in the usual manner for the first 15 min or more. After this time, the gage is attached and the needle valve opened. The completed assembly is then shaken and immersed in the bath and brought to equilibrium. Usually no more than a second or third shaking is required in order to secure consecutive gage readings.

This device eliminates seven or eight severe shakings of the gage and thereby reduces the abuse and wear on its delicate mechanism. At the same time the accuracy of the test is in no way affected.

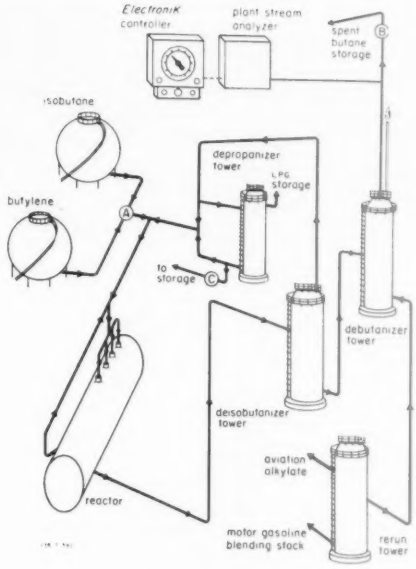
†Class B, honorable mention, NGAA Kinks Contest.

*Arkansas Fuel Oil Company, Shreveport, Louisiana.



New alkylation plant at Sohio's Toledo refinery

Simplified flow diagram of sulfuric acid alkylation process



Look to

The Infrared End Point

Continuous analysis reduces isobutane losses in the production of aviation alkylate at Toledo refinery

L. A. Beaudry*

THE Standard Oil Company of Ohio operates four refineries in the State of Ohio and one in Kentucky. One of these, located in Toledo, serves as a collection point for thermal and catalytic butanes produced at three of the other refineries. This butane product comes to Toledo through Sohio's extensive pipe line system and is further processed here into a high octane alkylate for use in aviation gasoline.

There are two alkylation plants at the Toledo refinery. The first went on stream on Pearl Harbor Day in 1941, the second was started up in August, 1953. Both employ sulfuric acid as a catalyst.

Two Critical Points

In the alkylation process, several factors influence the economy of operation. One of these is noted at point A (in the simplified process flow diagram) where a critical ratio of isobutane to butylene must be maintained in the reactor feed. If the ratio is too low, improper operation of the plant will result. On the other hand, too high a ratio increases the loss of valuable isobutane in the debutanizer overhead —point B.

*Standard Oil of Ohio.

EXCLUSIVE

Until recently, Toledo refinery's alkylation units were controlled by means of the conventional methods where temperature, flow, pressure, and level controllers automatically maintained desired product composition. This method worked well as long as feed composition remained reasonably constant. But normal variations in plant feed repeatedly upset it, and as a result, substantial quantities of isobutane were lost in the debutanizer overhead. These losses easily justified a $7000 capital expenditure for a plant stream analyzer and an electronic controller described in the following paragraphs. The new end point control system has been so successful—payout was completed in less than six months —that a second one was installed on the merits of the first.

End Point Analysis

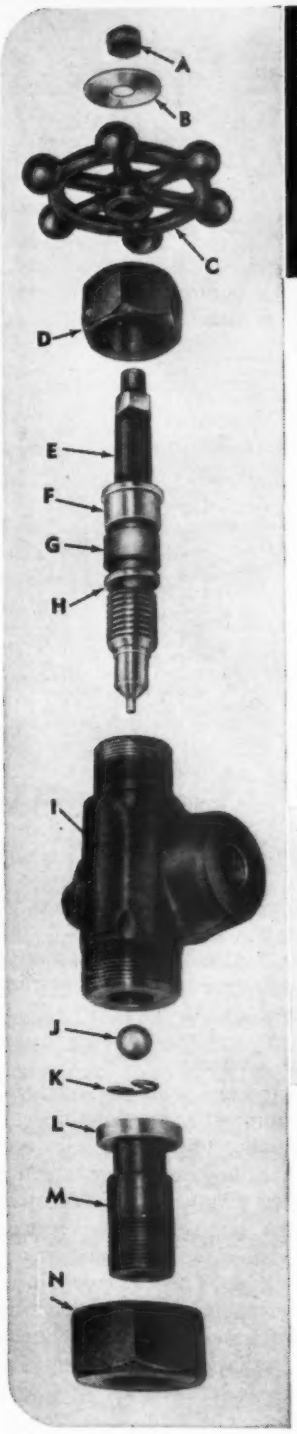
A portion of the debutanizer overhead stream is passed continuously through the analyzer. Because the analyzer is sensitized only to isobutane, its electrical output depends upon the selective absorption of infrared energy by the isobutane in the plant stream, and is recorded by a potentiometer directly in terms of per cent isobutane. The chart record therefore constitutes a continuous quantitative analysis of per cent isobutane in the debutanizer overhead stream.

End Point Control

Each of the analyzers at Toledo refinery is equipped for automatic control. Originally, the electronic controller reset a flow controller which in turn operated a valve in the depropanizer bottoms line (C in the process diagram) whenever it detected an excess of isobutane. This cascade control system diverted to storage substantial quantities of isobutane that previously had been discharged in the spent butane stream. Calculated on this basis alone, a single end point analyzer resulted in annual savings of $35,000.

But as Sohio's engineers accumulated information and experience, they found that better results could be obtained by adjusting the ratio of isobutane to butylene in the reactor feed (A in the process flow diagram) according to the results of the recorded analysis. The new procedure enabled them to establish and maintain the critical isobutane —butylene ratio much more closely than ever before had been possible. As as result, the whole alkylation process was so improved that excess isobutane *i.e.* in quantities greater than is considered practical for economic operation) was virtually eliminated from the debutanizer overhead.

Currently, end point control at



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- L Patented "Floating Shank"
- M Steel Tailpipe
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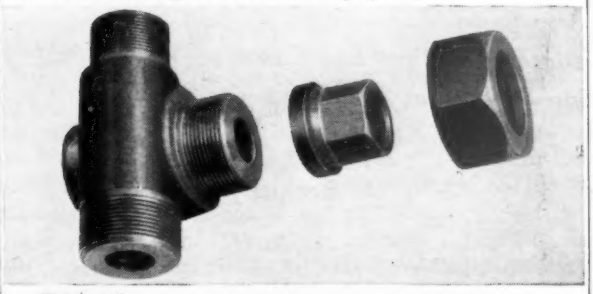

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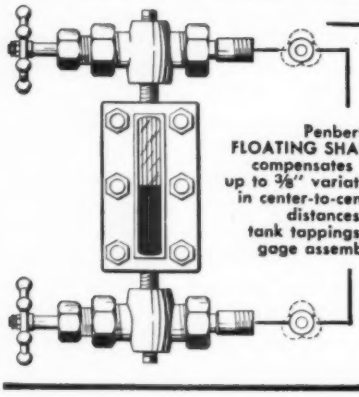

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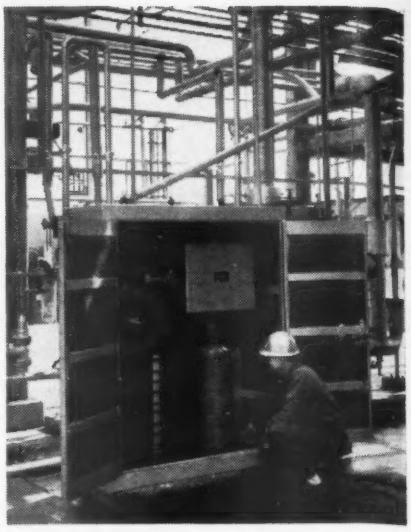

Steam-heated and insulated box houses infrared analyzer, sampling equipment, and standard samples

Toledo refinery is a manual operation that consists in resetting the flow controllers in the reactor feed line. It is expected, however, that a further study of process lags and related variables will improve the system one step further and again make the control function completely automatic.

The Analyzer

There are three essential parts to the plant stream analyzer: Infrared analyzer, voltage regulator, and recording potentiometer. The analyzer proper is a non-dispersive, selective type of spectrophotometer that is housed in an explosion-proof cast aluminum box and is mounted near the debutanizer tower. Both the commercial voltage regulator, which controls the power supplied to the analyzer, and the recording potentiometer are located in the control room. The potentiometer, a circular chart model, features a special high-gain amplifier that eliminates the need for a preamplifier and thus greatly simplifies the electrical system.

The Sampling System

As in all analytical procedures, the results obtained by the analyzer can be no better than the sample prepared for it. Accordingly, Sohio's engineers have devised appropriate sampling equipment and techniques for the Toledo refinery installation.

A tap on the debutanizer overhead furnishes a vapor sample at 80 psi. In order to reduce this pressure to atmospheric and yet deliver the sample to the analyzer at 80 to 100 F and still in the vapor phase, the sampling line is steam-traced and insulated. At ground level, the line enters an insulated box that houses the infrared analyzer proper as well as several important pieces of sampling equipment. These are illus-

Central control room for the new alkylation plant. ElectroniK controller at left records per cent isobutane

trated in the photograph and described in the following:

1. **Filter:** A simple gas filter knocks out solids and liquids that could otherwise damage the analyzer or cause erroneous analysis.

2. **Dryer:** For the analysis of isobutane, sodium chloride cell windows increase analyzer sensitivity. This material is hygroscopic, and must be kept free of water vapor to prevent etching. Calcium sulfate is the drying agent.

3. **Constant differential pressure relay:** A purge meter and constant differential relay assembly maintain a uniform rate of flow in the sample line to the analyzer regardless of variations in pressure. The assembly improves analytical accuracy considerably because the analyzer is sensitive to small fluctuations in flow rate.

4. **Control of ambient temperature:** The infrared analyzer proper is equipped with an integral temperature control system that effectively overcomes most conditions of ambient temperature. But when the analyzer is field-mounted, as at Toledo refinery, changes in ambient temperature can be very severe and so require that additional steps be taken to eliminate their effect. This is why a steam-heated and insulated box for the sampling system and analyzer has been provided. A simple, self-operated temperature regulator on a low-pressure steam line in the insulated box keeps the temperature between 80 and 100 F the year round.

Maintenance Is the Key

Experience with the two analyzers at Toledo refinery indicates that a first class instrument mechanic can easily keep these instruments on stream 90 to 100 per cent of the time if certain simple, but important, precautions are taken. First, a suitable sampling system that incorporates ambient temperature and flow control must be provided. Second, zero and span checks must be performed at regular intervals. And finally, the analyzer must be properly maintained, with the accent on preventive maintenance according to the manufacturer's recommendations.

Although slightly more involved than that required for typical industrial instruments, such a maintenance program is certainly within the scope of the average instrument group and is fully justified on the basis of the results obtained.

Standardization Procedure

A regular schedule of standardization checks not only insures analytical accuracy but also promotes operator confidence in the analyzer.

A "zero check" of the analyzer is performed daily with a single standard sample whose analysis is in the vicinity of four per cent isobutane. The instrument mechanic also performs a "span check" once a week, for which he needs two standard samples: The four per cent isobutane sample and one whose isobutane content approaches 20 per cent. Both samples are tapped from the debutanizer overhead stream and are collected in steel cylinders. This procedure insures that all infrared absorbing compounds that are normally present in the plant stream are also present in the standard samples at their average concentration. After analysis on a mass spectrometer, the cylinders are tagged according to the results of the spectrometric analysis, and placed in the insulated box where they are readily accessible to the operators.

Additional comparisons between infrared analyzer and mass spectrometer analyses supplement the zero and span checks. At unscheduled but frequent intervals, a sample "bomb" is filled with vapor from the debutanizer overhead, the current analysis of per cent isobutane on the recorder is noted and the contents of the bomb are analyzed on a mass spectrometer. The close agreement between spectrometeric and infrared analyses has demonstrated the accuracy of continuous end point analysis and control. * * *

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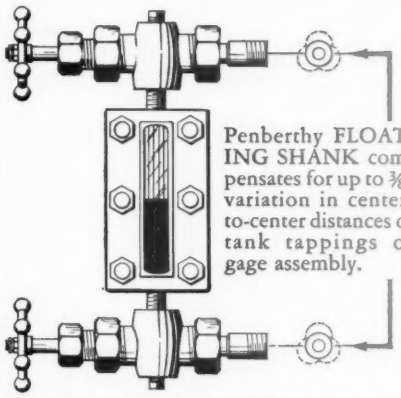

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XUM

NEW PROCESS makes 100 octane number gasoline

THE combination of a Platformer-like reforming process with selective solvent extraction and recycle of the resulting low octane number, high paraffin content raffinate results in a new reforming combination process that yields motor fuels of 100 or higher clear Research octane ratings from any sort of low-grade refinery naphthas. This was reported to the Western Petroleum Refiners Association's annual meeting in San Antonio, Texas, March 28-30. The process is called Rexforming and was developed by Universal Oil Products Company.

The reforming cycle is the typical Platformer system with a prefractionator to kick out any light material not desired further in the process. The main fraction residual—in this case the side-draw fraction from the tower is preheated and passed through a multiplicity of catalyst reactors, where it is reformed by a platinum-containing catalyst. The fraction is reheated before each reactor pass. Non-condensable, hydrogen-rich gas is taken off overhead from a separator, after passing through the cooler-condenser. A small bottoms is discarded.

From this point the process is analogous, but not identical, to the Platformer-Udex combination now employed in a number of refineries to produce high purity aromatics for special purposes. The reformate (Rexformate) from the separator passes to a stabilizer that amounts to a debutanizer, and then to a selective solvent extraction unit, where an unnamed selective solvent takes up the essentially aromatic and low-boiling paraffinic products, and rejects the less soluble paraffinic components. These become recycle stock combining with fresh feed to the reactors for further molecular rearrangement.

The extract from this operation is the finished Rexformate, made to the required specifications for the product wanted. Obviously, with a recycle system, the product may be made in a wide variety of specifictions at the operator's choice.

Due also to the recycle system, the reactors may be operated at milder conditions. The extraction-concentration step will reject the low octane rating material in this reactor exit stream, giving a Rexformate of 60-65 per cent aromatics.

Here is one of the outstanding principles in the process, say its progenitors. *Milder conditions degrade less charge stock, thus, other things equal, final overall yields will be higher.* Recycling rejected stock permits the operator to leave small amounts of aromatics, and similar material in this recycle stock, thus avoiding necessity for providing extremely efficient extraction capacity.

Lower Investment, Operating Costs

In one system of test runs, the temperatures used were more than 50 F lower than those that would typically be employed in a once-through (presumably Platformer) operation. Less catalyst was needed since a higher space velocity was maintained in the reactors; yet the octane ratings obtained were 95, with 56 per cent aromatics, and nearly 102, (CRC) with 77 per cent aromatics. For these same runs the yields of 10 lb Rvp reformate were 92.3 and 85 volume per cent, respectively. Clear F-1 octane rating of the charge stock was 30.

In another case the operators selected the naphtha with the lowest obtainable octane rating, "without going to synthetics," the paraffinic content being 85 per cent. While showing a lower yield than similar operations on a higher octane number stock from Midcontinent crudes, the yield of 10 lb Rvp gasoline was 74.3, with nearly 60 per cent aromatic content, an F-1 octane rating, clear, of 101—a truly remarkable performance, experienced refiners say.

In typical data on the various streams in an operation on Midcontinent naphtha, the charge showed 33 octane number, 9 per cent aromatics. Combined feed (fresh plus recycle feed) was 144.6 per cent of fresh feed, that is 44.6 per cent of the charge was recycled. Product stream from the reactor stabilizer showed 76 octane number, 37.5 per cent aromatics; the recycle stream was 41 octane number, 8.5 per cent aromatics, 44.6 per cent of fresh feed. The debutanized Rexformate (extract, before making up to 10 lb vapor pressure), showed 97.2 octane rating, had 53.5 per cent aromatics, and yielded 80.5 per cent of the fresh charge.

Typical Midcontinent naphtha Platformate products show (once-through) non-aromatics ranging from 20 to 40 clear octane number. The highest-boiling non-aromatics show the lowest antiknock properties.

Efforts to improve reformate quality by operating at reduced pressures showed that a product considerably higher in aromatics must be made to attain the required octane ratings, indicating that the non-aromatic (paraffinic) content of the reduced pressure reformate is of even lower octane number than that formed under higher pressures.

Researchers decided finally on partial conversion of the paraffin components under mild conditions, holding a suitable balance between dehydrocyclization (aromatization), and hydrocracking, and avoiding excessive coke-and-gas formation which reduces yields and makes for more costly operation. If this partial conversion scheme is followed, it must be combined with selective separation of the converted stock and recycle of that portion that is unconverted. This is the system that was developed.

The low-grade (low octane number paraffinic) recycle material can be reformed either in a separate catalytic unit, or it can be combined, as discussed here, with fresh stock in the same unit.

Another phase of this process operation is that all or any part of the highly paraffinic recycle stream may be recycled to the reformer, or any part may be withdrawn for use as finished product. It has little if any olefins or sulfur compounds; it is generally more than 90 per cent paraffinic and it has high recommendations for jet fuel.

It is estimated that the cost of a unit to operate this process as described will cost about $300 per daily barrel of throughput to build, and about 36¢ per barrel to operate, *for direct costs only*. Costs for royalty, depreciation, administration and overhead also must be calculated.

The accompanying tabulation shows the breakdown of costs. The process is considered one that will produce "any needed octane rating," and has the added advantage of producing highly paraffinic naphthas.

Estimated Investment and Operating Costs for Rexforming

Basis: 5000 bsd Midcontinent full boiling st. run gasoline* producing 101 F-1 clear Rexformate

	Total
Erected cost (Within battery limits)	$1,600,000
Operating costs ¢/bbl full boiling gasoline	
Operating labor @$ 2.75 per hour	4.0
Laboratory	1.0
Utilities	
Fuel @ 15¢/MM Btu	7.3
Power @ 0.8¢/KWH	4.0
Steam @ 30¢/M lb	4.6
Water @ 1¢/M gal	1.4
Catalyst	6.9
Solvent	1.7
Maintenance @ 3% of investment per year (Labor and materials)	2.8
Insurance and property taxes @ 2% of investment per year	1.9
Total operating costs excluding royalty, depreciation, administration and overhead	35.6

*4300 BSD fresh naphtha charge to reactor section.

* * *

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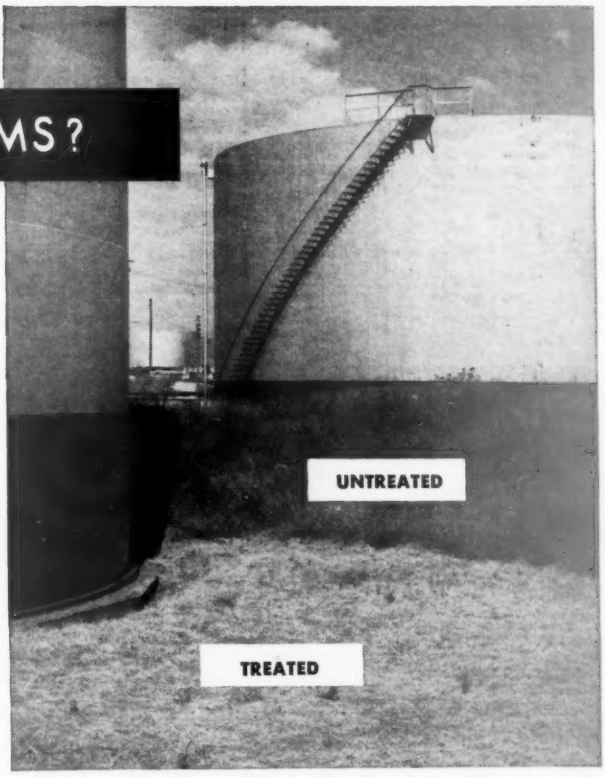

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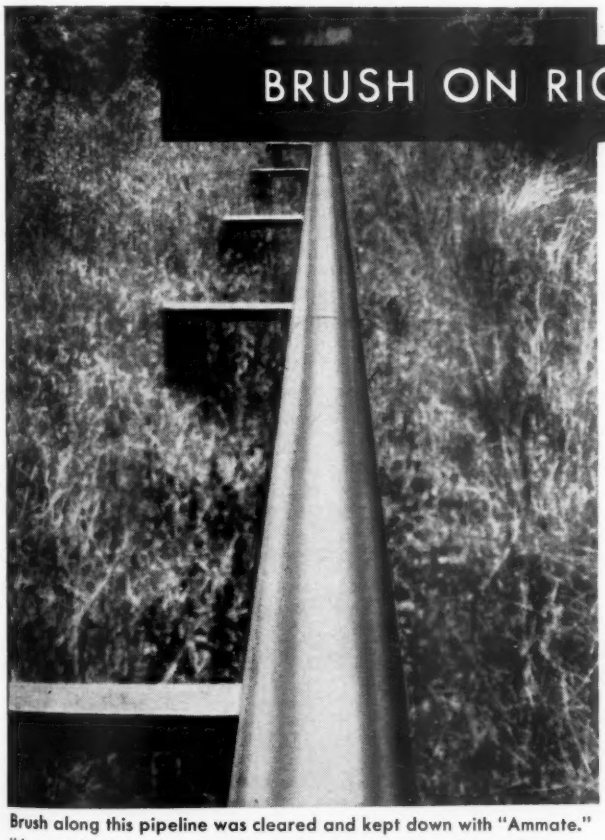

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On all chemicals always follow directions for application. Where warning or caution statements on use of product are given, read them carefully.

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PERSONALS

Edward W. Isom, chairman of the board of Sinclair Research Laboratories, Inc., officer and director of other Sinclair companies, has retired from active executive duties. He will continue to serve Sinclair as consultant in the field of petroleum refining technology. Isom is one of the pioneers in the field of refining processing. He joined Sinclair at its inception May 1, 1916, and has served as vice president in charge of new construction and operation of all refineries, vice president in charge of research and development and president of Sinclair Rubber, Inc. He was instrumental in setting up the refining division of API and has served on many committees of that division. He is a graduate of Colorado School of Mines and has won many honors for notable achievement in the oil industry engineering field.

Francis L. Cannon has joined Standard-Vacuum Oil Company in Bombay, India. Formerly with The Texas Company in Tulsa, he has accepted his new position to operate the catalytic cracking unit at Stanvac's new 25,000-bbl a day Bombay refinery. He will instruct natives in operating the unit.

Seven young chemists have joined the development and research department of Continental Oil Company in Ponca City. The new employees, according to E. R. Baker, department manager, are **C. V. Foster** as senior chemical engineer in the petrochemical research division; **Paul A. Lobo** as research chemical engineer in the division; **Carlton L. Hassell,** research mathematician in the production research division; **Calvin F. Meyers,** senior research engineer in the product use laboratory; **Mary Ann Davis,** junior chemist in the central research laboratories; **Robert L. Carden,** junior chemist in the petrochemical research division, and **W. R. Beaty,** junior chemical engineer in the process laboratory. Foster was previously with Ethyl Corporation, Hassell with Sandia Corporation, Meyers associated with Boeing Aircraft, and Miss Davis with duPont. Carden has been a high school science teacher. Lobo and Beaty are recent college graduates, Lobo with a doctor's degree in chemical engineering from the University of Michigan, and Beaty with a BS, chemical engineering, from the University of Arkansas.

C. C. Crawford will conduct studies for Husky Oil Company in the field of petrochemicals. A graduate of Arkansas College, with a master's from Emory University and a Ph.D. in chemistry from Yale, Crawford has been with Phillips Petroleum Company. In announcing his association with Husky, Glenn E. Nielson, president, said that his company has viewed with interest developments in the field of petrochemicals for some time and now "feels that it should survey closely this important branch of the petroleum industry."

Humble Oil & Refining Company has announced promotions of **R. M. Love,** to section head, and **O. H. Dawson,** to senior research chemist in Research and Development division. **E. D. Gurtler** moves up to technical specialist; **D. C. Clark, Bartlett Johnson, J. T. Moody,** and **W. K. Roquemore,** to the senior chemical engineers, all in the Technical Service division.

Continental Oil Company's petrochemical department has a new market development representative—**Paul B. Geiser.** Formerly superintendent of Conoco's petrochemical plant in Chicago, Geiser is moving to Houston in his new post. He is a graduate of Purdue and was with Sharples Chemical Company before joining Conoco in 1948. **K. R. Gehardt** will succeed Geiser as plant superintendent in Chicago. He has been with the company since 1947 and is a graduate of Lebanon College. **Robert L. Kylander,** a master's degree graduate of Oklahoma A&M, is new staff engineer for Conoco in Houston. He has been with the company since 1949. **Robert L. Maples,** who joined Conoco last year after serving two years in Brazil as a consultant to the Brazilian government's petroleum agency, is process and sales service engineer at Baltimore, Maryland, replacing Kylander. Maples took a master's degree in chemical engineering from the University of Tulsa.

Sinclair Refining Company has four new vice presidents. They are **C. R. Campbell, A. J. Geary, T. B. Kimball,** and **W. M. Flowers,** president of Sinclair Research.

Standard Oil Company (Indiana) has made a number of personnel changes at its Whiting, Indiana, laboratories. **Frank A. Beuhler** is new assistant head engineer in the process engineering division as supervisor of design. **H. S. Conway** and **R. A. Dinerstein** are section leaders in the analytical research division. **J. E. Barney II** and **F. J. Piehl** are group leaders reporting to Dr. Conway and **J. C. Winters** is group leader reporting to Dinerstein. **J. G. Toplin** is new technical associate in the information development division. **W. A. Proell** is section leader responsible for work on solid rocket propellants. **K. W. MacFie** is project superintendent of the Seymour, Indiana, laboratory, and **N. J. Bowman** is group leader.

Richard P. Jeffery is new maintenance superintendent of Great Northern Oil Company, St. Paul, Minnesota. A veteran in the oil industry, Jeffery was associated for the past 22 years with Lemont Refinery, Globe Oil and Refining Company. The company was recently purchased by the Pure Oil Company.

New NGAA Committee on Eqilibrium Ratios. Dr. Elliott Organick, Union Producing Company, seated second from the left, is chairman of a newly appointed committee of the Natural Gasoline Association of America assigned the task of supervising publication of a comprehensive book of vaporization-equilibrium constants. Other members of the group and guests at the first meeting are, seated: J. W. Kilmer, Stanolind Oil and Gas Company; Organick; Blaine B. Kuist, Fluor Corporation, Ltd.; Karl H. Hachmuth, Phillips Petroleum Company; William Leggett, Fluor Corporation, Ltd. Standing: Chairman NGAA Technical Committee, Charles E. Webber, Sun Oil Company; Dr. C. L. De Priester, California Research Corporation; H. H. Rachford, Humble Oil and Refining Company; Dr. Byron B. Woertz, The Pure Oil Company; and Robert Jacoby, Stanolind Oil and Gas Company.

News Nuggets:

Trans-Canada Pipe Lines, Ltd., has signed its first gas purchase contracts, for over 125,000,000 cu ft daily, to be supplied by Hudson's Bay Oil and Gas Company, Canadian Delhi Oils, Canadian Export Gas, West Maygill Gas and Oil, Great Sweetgrass Oils, and Western Petroleum Leases. The volume is approximately one-fourth of the total capacity of the line, and according to Trans-Canada president N. E. Tanner, enough to meet first year needs of the pipe line project.

Trans-Canada is also in the news financially. Unless financing of the 2250-mile big inch gas line project is resolved shortly, chances for a construction start in 1955 are quite remote. Informed sources say the Canadian Parliament would be reluctant to sanction a guarantee for bonds in the amount of $275,000,000 needed for construction of the line. The pipe line company most likely will be told to arrange its own financing, rather than depend on government support.

The Air Force is continuing to investigate the feasibility of supplying its airbases throughout the country by direct transportation of petroleum products through pipe lines. Receiving greatest consideration are those lines in common carrier service near the various bases. The Air Force is reluctant to become tied to lines serviced by products of a single refinery. All forms of transportation—rail, truck, barge, pipe line—are being studied.

Westcoast Transmission Company has started surveys on its 650-mile, 30-in. line to bring gas from the Peace River area of northern Alberta and British Columbia to Vancouver and the U.S. Pacific Northwest. Canadian Bechtel is in charge of the work, and crews will continue working north as weather permits. Construction is slated for early autumn and completion in 1956, provided the FPC sanctions the recent agreement reached by Westcoast and the Pacific Northwest Pipe Line Company on gas service to the areas concerned.

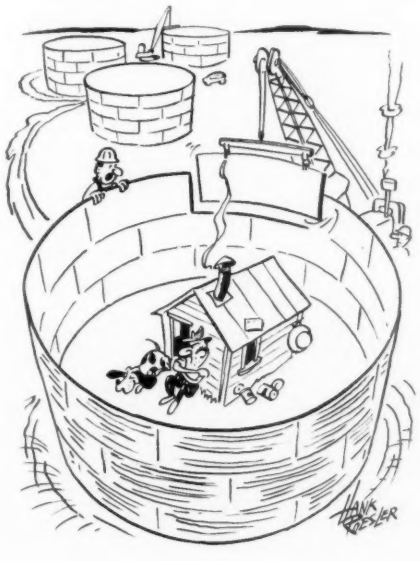
Southern Pacific Pipe Line Company, a subsidiary of Southern Pacific Railroad (see Pipe Line Projects, this issue) has its first outspoken critic, the Teamsters Union local (AFL) in Los Angeles, California. The union has asked its international officers in Washington, D.C., to direct efforts at getting government agencies concerned to block the company's proposed project.

Two products pipe lines have revised their minimum octane ratings on gasolines moving through their systems. Great Lakes Pipe Line Company's specifications on premium gasoline have been raised from 92 to 94 octane, and on regular grade from 84.5 to 86 octane. Oklahoma Mississippi River Products Line has announced minimums of 97 for premium grade and 86 for regular on its shipments.

Reserves of natural gas and crude oil as of December 31, 1954, have set new records, according to a joint report issued by the American Petroleum Institute and the American Gas Association. Crude oil reserves at the year's end totaled approximately 29.6 billion bbl, compared to 28.9 at the end of 1953. Natural gas reserves reached a new high of 211.7 trillion cu ft, an increase of 263 billion cu ft over 1953's total of 211.4 trillion cu ft. Recoverable reserves of natural gas liquids had a slight decrease, with 5.2 billion bbl of condensate, natural gasoline, and liquefied petroleum gas compared to 5.4 billion bbl at the same time in 1953.

Transcontinental Gas Pipe Line Corporation is readying for a major construction program this spring and summer that will increase daily capacity 130,000,000 cu ft daily; add 315 miles of 36-in., 219 miles of 30-in., and 46 miles of smaller pipe; and provide a system that is 45 per cent looped between production areas and the New York market areas.

A revised map of major natural gas pipe lines in the U.S., dated December 31, 1954, has been issued by the FPC. The four-color, 13 by 19-in. map shows existing major lines, those under construction or authorized but not yet started, and proposed lines pending before the commision. Copies are available from the FPC at 25 cents each on order number FPC M-42.



"Better mosey along, Buster — or do you breathe under 40 feet of oil?"

George L. Chapman, Wolverine attendant at Hammond, Indiana, transmits pipeline operations data to New York over a Bell System teletypewriter circuit

"Bell System furnishes us dependable communications at a price we can't equal"

—says Cyrus S. Gentry, President of the Wolverine Pipe Line Co.

Flexible, low-cost communications is what Wolverine Pipe Line Company is getting by renting private line teletypewriter service from the Bell System.

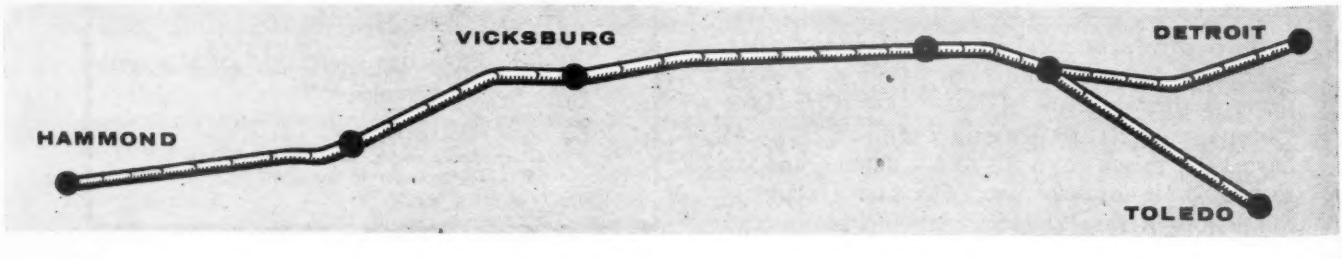
From Hammond, Indiana, products are started along the 295 miles of 16-inch pipe line to Detroit and Toledo. By using a Bell System teletypewriter circuit the operator starts or stops the big high-pressure pump at Vicksburg, 125 miles away.

Hundreds of miles east in New York, a dispatcher keeps round-the-clock watch over the Wolverine Pipe Line's seven stations. He gets reports and sends orders over Bell System teletypewriters.

"The expense of a privately owned system would be far in excess of a rented circuit," says a Wolverine official.

To find out how your communications efficiency could be improved, and costs lowered by using Bell System service, ask your Bell Telephone representative.

BELL TELEPHONE SYSTEM



PIPE LINE DEVELOPMENTS

★ ★ ★

Roundup of Current Planned and Proposed Construction

NAME OF COMPANY	MILES	PIPE SIZE	LOCATION
CRUDE LINES			
Ar-Mex Pipeline Co.	790	12-14	Guernsey, Wyoming to Coolidge, Arizona
Kaybee Pipe Line Company	46	10	Griffith, Indiana, to New Buffalo, Michigan
Magnolia Pipe Line Company	215	12-14-16	Loops on West Texas to Corsicana system
Michi, Inc.	222	10	Highland, Indiana, to Elsie and Alma, Michigan
NNCW Pipe Line Co.	127	8-10	Weston County to Casper, Wyoming
Orchard Pipe Line	45	8	Orchard to Merino, Colorado
Peace River Oil Pipe Line Co., Ltd.	200	12-16	Peace River area to Edson station on Trans-Mountain near Edmonton, Alta
Powder River Pipe Line Company	436	10-16	Williston Basin to Laurel and Billings, Montana
Proven Oil & Refining Company	32	8	Connection with West Coast Pipe Line to Florence, Ariz.
Roosevelt Oil & Refining Corp.	22	4.6	St. Helen to Norwick, Michigan
Skelly Oil Company	14	6	Lines in Reno and Kingman counties, Kansas
Shell-Murphy Company	450	16	Williston Basin area of Eastern Montana to Gurley and Ft. Laramie, Wyoming
Standard Pipe Line Co.	350	16	Glendive, Montana, to Guernsey, Wyoming
Standard Pipe Line Co.	350	16	Wink, Texas, to Albuquerque, New Mexico
Sinclair Pipe Line Company	31	12-16	Monee to Lemont, Illinois
Trans Mountain Oil Pipe Line Corp.	27	20	Laurel Junction to Mt. Vernon, Washington
West Coast Pipe Line Company	960	20-22	Wink, Texas, to Norwalk, California
PRODUCTS LINES			
American Pipe Line Company	1910	8 to 26	Beaumont, Texas, to Newark, New Jersey, with laterals
California-Oregon Pipe Line System	103	6	Crescent City, California, to Medford, Oregon
H. W. Bass & Sons, Incorporated	152	4-6	Duval and Live Oak Counties, Texas, to Corpus Christi, Texas
Bell Oil and Gas Company	140	6-8	Ardmore to Cushing, Oklahoma
El Paso Natural Gas Co. (LPG Line)	119	3-6	Bloomington to Gallup, New Mexico
Goliad Corporation (LPG Line)	117	4-6	Kittie Plant to Corpus Christi, Texas
Inland Corporation	22	6	Springfield to Dayton, Ohio
Inland Corporation	37.5	10	Toledo to Fostoria, Ohio
International Pipe Line Inc.	132	8	Wrenshall to Minneapolis, Minnesota
Keystone Pipe Line Company	48	8	Boot Station to Fullerton, Pennsylvania
Malco Pipeline, Inc.	91	6	Prewitt to Albuquerque, New Mexico
Mayflower Pipe Line Company	—	—	New Jersey refineries to New England points
Moore-Stoner Company	200	6	Glendive, Montana, to Minot, North Dakota
Sioux Oil Company	50	6	Newcastle, Wyoming, to Rapid City, South Dakota
Socony-Vacuum Oil Co. Eastern Pipe Lines	5	12	Linden, New Jersey to Port Socony on Staten Island, N. Y.
Southern Pacific Pipe Lines Company	800	6 to 16	New products lines system in California, Arizona, New Mexico and Texas to be built and operated by Southern Pacific Railroad Co.
Sunflower Pipe Line Company	265	3-6	Kearny, Grant and Haskell counties to Wichita, Kansas
Texaco-Cities Service Pipe Line Company	45	8	West Tulsa to Cushing, Oklahoma
Winnipeg & Central Gas Co. (LPG Line)	450	4 or 6	Tioga, N. D., to Winnipeg
GAS LINES			
Alberta Gas Trunkline	315	18-36	Gas Gathering System in Alberta fields
American-Louisiana Pipe Line Company	1120	22 & 30	Lowry, Louisiana, to Detroit, Michigan
Anadarko Basin Pipeline Co.	525	24	Wise County, Texas, to Memphis, Tennessee
Arkansas-Louisiana Gas Company	136	8 to 24	Loops on System
Central Hudson Gas and Electric Co.	48	12	TGT line to Kingston, N. Y.
City of Fayette, Alabama	20	5	Fayette, Alabama, to Southern Natural's system
Coast Counties Gas Electric Company	40	3-4-8	Coast and Valley Region, California
Coastal Transmission Corporation (c/o Delhi Oil, Dallas)	400	30	McAllen to Beaumont, Texas
Colorado Interstate Gas Company	365	22	Green River, Wyoming to Denver, Colorado
Colorado Interstate Gas Company	110	6-8	Julesburg area to Denver, Colorado
Colorado-Western Pipe Line Co.	328	16-18	Ignacio field to Pueblo and Denver
Colorado-Western Pipe Line Co.	454	—	Cortez to Denver System
Colorado-Western Pipe Line Co.	250	—	Lateral lines
Cumberland and Allegheny Gas Co.	31	12	Garrett County, Maryland, to Keyser, West Virginia
El Paso Natural Gas Co.	370	—	Mountain Home, Idaho, to Reno, Nevada
El Paso Natural Gas Co.	74	—	Additions to Permain Basin-San Juan Basin system
Fort Worth Basin Gas Company	—	—	Brown and Comanche counties, Texas
Kansas Pipe Line Company	125	16-20	Barber County fields to Wichita, Kansas
Kansas-Nebraska Natural Gas Company	206	6-12	Additions to Nebraska system
Manufacturers Gas, Light & Heat	40	—	Allegheny, Washington, and Beaver counties, Pa.
Manufacturers Gas, Light & Heat	213	3 to 26	Various points on system in Pa., W. Va., and Ohio
Manufacturers Gas, Light & Heat	72	16-20	Doddridge, Wetzel and Marshall Counties, West Va.
Michigan Consolidated Gas Company	25		Sparta to Muskegon, Michigan
Michigan-Wisconsin Pipe Line Company	252	4-24	Loops and stations in Illinois
Mississippi River Fuel Corporation	190	10-18	Laterals in Woodlawn and Waskom gas fields, Texas
Morganfield Natural Gas	31	4-6	Through Sturgis, Providence, Clay, Diamond, Wheatcroft and Sullivan, Kentucky
Natural Gas Pipe Line Co. of America	350	20-26	Amarillo to Wise County, Texas
Natural Gas Producer, Inc.	100	12	Yenter pool to Denver, Colorado
Natural Gas Producer, Inc.	61	4-10	Northeast Colorado lines
Natural Gas Storage Company	35	36	Storage field areas near Chicago to main lines
New River Gas	50	—	Sumners to Monroe counties, West Virginia
North Dakota Natural Gas Company	475	6-12	Statewide system in North Dakota
Northern Indiana Fuel & Light	35	8	Edgerton to Alburn, Indiana
Northern Natural Gas Company	330	2-12	System in South Dakota
Northern Natural Gas Company	310	24	Lines in North Dakota
Northern Natural Gas Co.	403	24-30	Canadian border to Minneapolis-St. Paul
Northwest Utilities Ltd.	42	—	Bonnie Glen to Edmonton, Alberta, Canada
Pacific Northwest Pipeline Corp.	1486		Ignacio, Colorado to Bellingham, Washington
Pacific Northwest Pipeline Corp.	380		Laterals and spurs off main line to Pocatello, Idaho, to Yakima, Washington
Pine Tree Natural Gas Co.	204	—	Boston to Bangor, Maine
Rockland Light & Power Company	22	8	Orangetown to Tompkins Cover, New York
Shenandoah Gas Company	39	3-4-8	Middleton, Virginia, to Martinsburg, West Va.
Tennessee Gas Transmission	243	24	Hebron, Pennsylvania to Greenwich, Connecticut
Tennessee Gas Transmission	370	30	Agua Dulce, Texas, to Kinder, Louisiana
Texas Eastern Transmission Corp.	328	24	Beaumont to Kosciusko, Mississippi
Texas Gas Transmission Co.	90	20-26	Loops on main line
Texas Gas Transmission Co.	100	10-20	New Indiana lateral line
Transcontinental Gas Pipe Line Corporation	125	—	Ulster County, New York (Pheoncia) to New York City
Transcontinental Gas Pipe Line Corporation	315	36	Loops on main system
	219	30	Loops on main system
Transcontinental Gas Pipe Line Corporation	46	12-16	Other new lines
Trans-Canada Pipe Lines, Ltd.	2247	14-34	Alberta area to Toronto, Montreal
Union Gas Company of Canada	180	—	Dawn Storage field to Hamilton
United Natural Gas Company	50	12	Elk County to Jefferson County, Pennsylvania
Utah Natural Gas Company	40	16	Orem to Salt Lake City, Utah
Virginia Natural Gas Company	153	—	Buckingham to Richmond and Portsmouth, Va.
Warren Petroleum	54	4-30	Lea County, New Mexico
Westcoast Transmission Co., Ltd.	650	30	Peace River area, Alberta, to U. S.-Canadian border
Wilcox Trend, Gathering System, Inc.	16	6	Loop near Provident City, Texas. Also plans additions to gathering systems.
Wyoming Gas Products Corp.	—	—	Gas gathering system in Weston County, Wyoming

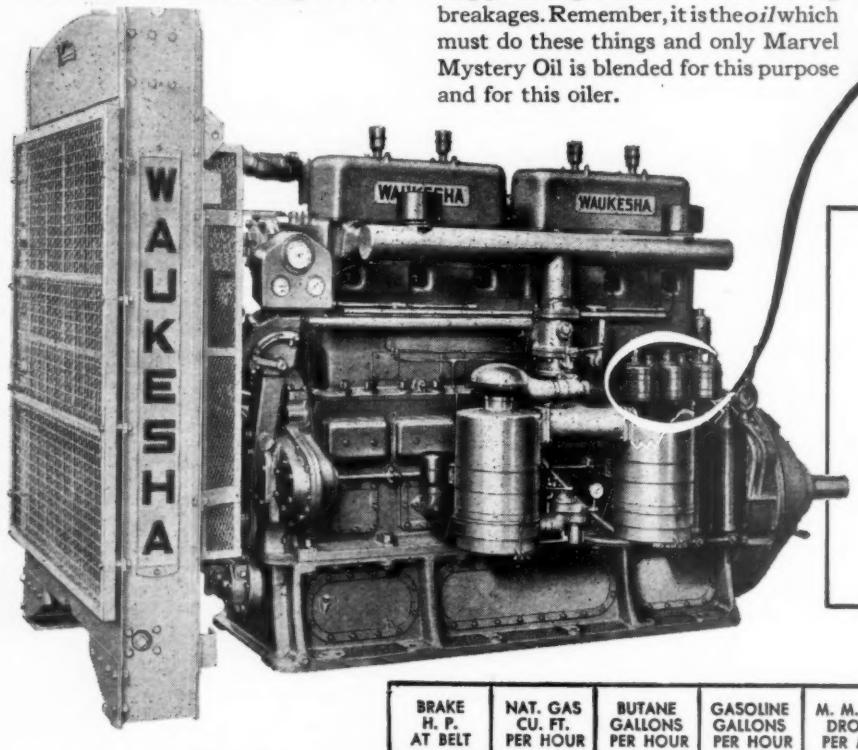
MARVEL INVERSE OILER-
Vital Part of World's Finest Engines

Engine manufacturers think so highly of the Marvel Inverse Oiler they have incorporated it as a vital unit in their engines' lubrication systems.

They have found that engines, equipped with Marvel Inverse Oilers, can be depended upon to give quick acceleration to save trip time . . . keep operating costs to a minimum . . . guarantee hours of continuous performance . . . keep "down-time" low by extending periods between overhauls.

The famous Waukesha Engines, one of which is pictured below, is an example. A truly fine performer, it is equipped with a Marvel Inverse Oiler for Marvel Mystery Oil—finest performing lubricant of all.

The Marvel Inverse Oiler feeds Marvel Mystery Oil in exact proportion to engine speed and load . . . properly lubricating valves and guides, preventing wear and sticking. Keeps upper piston rings free in their grooves . . . retards ring flutter . . . and cushions ring pounding which can result in ring breakages. Remember, it is the *oil* which must do these things and only Marvel Mystery Oil is blended for this purpose and for this oiler.



The Marvel Inverse Oiler

is an integral part of the Waukesha 550 H.P., 1200 RPM gas fuel engine. Operating off the intake manifold, these three completely automatic Oilers feed Marvel Mystery Oil exactly in proportion to engine loads . . . give direct protection to the all-important upper cylinder areas.

BRAKE H. P. AT BELT	NAT. GAS CU. FT. PER HOUR	BUTANE GALLONS PER HOUR	GASOLINE GALLONS PER HOUR	M. M. OIL DROPS PER MIN.	M. M. OIL HOURS PER QUART
10	115.	1.07	1.12	4	228
15	172.5	1.60	1.68	6	152
20	230.	2.14	2.24	8	114
25	287.5	2.67	2.80	10	91
30	345.	3.21	3.36	12	76
35	402.5	3.74	3.92	14	65
40	460.	4.28	4.48	16	57
45	517.5	4.81	5.04	18	50
50	575.	5.35	5.60	20	45
60	690.	6.42	6.72	24	38
70	805.	7.49	7.84	28	32
80	920.	8.56	8.96	32	28
90	1035.	9.63	10.08	36	25
100	1150.	10.70	11.20	40	22
120	1380.	12.84	13.44	48	19
140	1610.	14.98	15.68	56	17
160	1840.	17.12	17.92	64	14
180	2070.	19.26	20.16	72	12
200	2300.	21.40	22.40	80	11
225	2587.5	24.00	25.20	90	10
250	2875.	26.75	28.00	100	9
275	3162.5	29.42	31.10	110	8
300	3450.	32.10	33.60	120	7

This Chart shows the proper setting for constant load engines ▶

◀ ***Chart shows total oil consumption***

EXAMPLE:—If you use 805 cu. ft. of dry gas, 7.49 gallons of butane or 7.84 gallons of gasoline, your H.P. is about 70, so adjust oiler to feed 28 drops per minute. You will then receive about 32 hours per quart of MARVEL MYSTERY OIL.

If engine load increases after setting for normal load, oiler will automatically increase its feed, decreasing when load is lessened.

To determine drop count per oiler when more than one is used on an engine—divide recommended drop count by number of oilers.

NOTE: Guarantee on oiler is void if any other oil than MARVEL MYSTERY OIL is used. Some *engines* also carry this guarantee policy.

See Your Local Jobber or Oil Well Supply House

EMEROL MFG. CO.

Dept. 428, 242 West 69th Street New York 23, N. Y.

XUM

PIPE LINE PROGRESS

26-inch A. O. Smith line pipe on location during Interprovincial's 1954 looping program.

Interprovincial's third looping project uses 386 miles of A. O. Smith line pipe

A. O. Smith supplied 386 miles of pipe to Interprovincial Pipe Line Company for its 1954 looping program. This total includes 190 miles of 24 inch pipe and 196 miles of 26 inch pipe. Our shipments, each on schedule, started in May and the loop was completed in October.

On the job from the start, A. O. Smith has served Interprovincial in three key phases of line construction. We supplied all the 20-in. and 18-in. pipe used in the company's original line from Edmonton, Alberta, to Superior, Wisconsin. The 20-in. main links Edmonton and Regina . . . while the 18-in. line completes the run from Gretna, Manitoba, to Superior. Total here was 864 miles of line pipe.

The second looping project brought another call for A. O. Smith line pipe — 135 miles of 24-in. pipe to loop the Saskatchewan and Manitoba sections in the system.

A. O. Smith is proud to have participated in the building of this great transcontinental system — the world's longest crude line — now transmitting western Canadian crudes all the way from Edmonton to Sarnia, Ontario. This participation demonstrates our ability to meet delivery schedules anywhere on the continent. Both our Milwaukee and Houston mills served to supply Interprovincial with high quality, internally expanded, welded line pipe.

A. O. Smith line pipe is available in a complete range of sizes and wall thicknesses, from 8 5/8-in. to 36-in. diameters.

Through research ...a better way

A.O.Smith

CORPORATION

TUBULAR PRODUCTS DIVISION

Milwaukee 1, Wisconsin

Chicago 4 • Dallas 2 • Houston 2 • Los Angeles 22
Midland 5, Texas • New Orleans 12 • New York 17 • Pittsburgh 19
San Francisco 4 • Seattle 1 • Tulsa 3 • Washington 6, D. C.
International Division: Milwaukee 1, Wisconsin

pipe line instrumentation report

Overall view of the 2000-hp engine-driven compressor unit, showing control panel at left foreground

just one switch . . .

TO START AND LOAD MAINLINE COMPRESSORS

. . . new single-switch control system gives promise of operating economies for reciprocating compressor stations

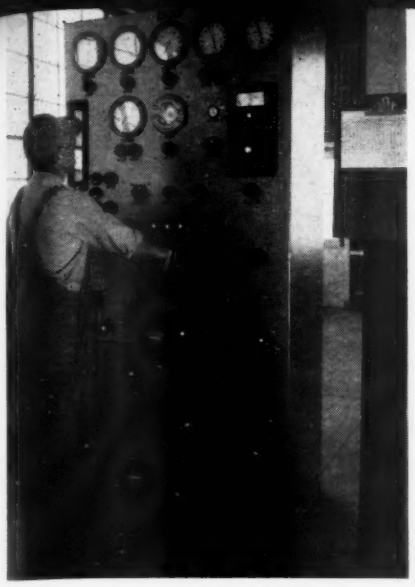
E. N. Sampson

EXCLUSIVE

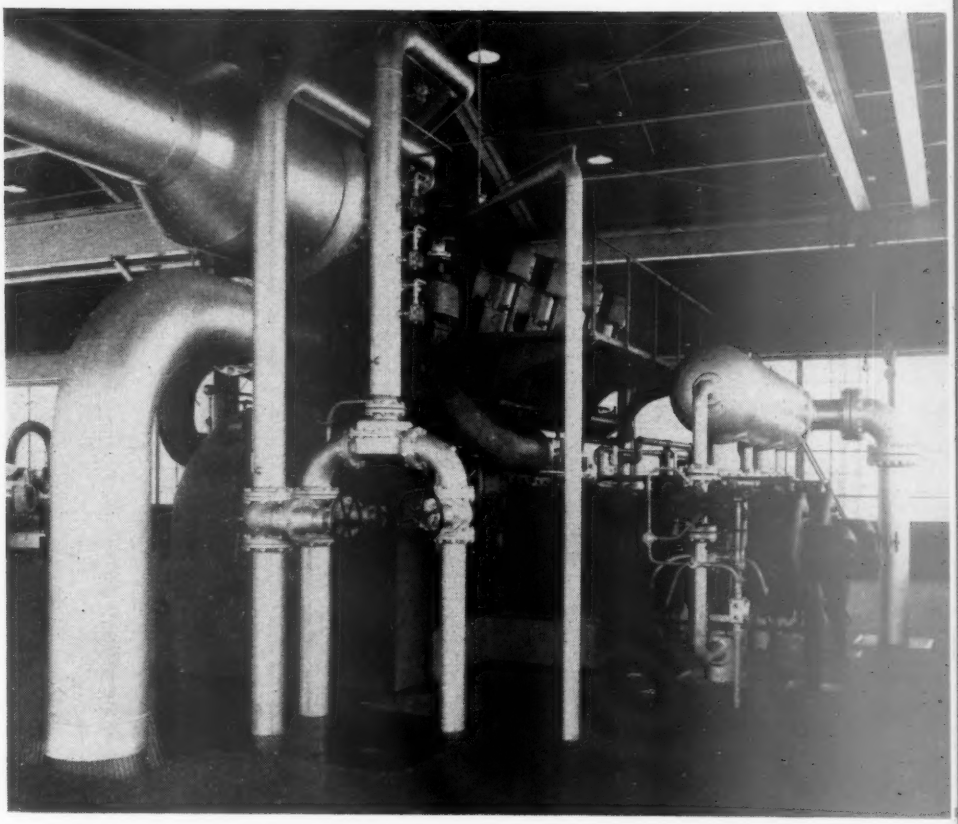
SINGLE-switch control automation for mainline reciprocating compressor stations has become an accomplished fact, an achievement reached by joint efforts of a major gas pipe line company and a compressor builder. A 2000-hp compressor now operating at Northern Natural Gas Company's mainline station, Mullinville, Kansas, is believed to be the first large reciprocating mainline compressor of its kind operated entirely by energizing a single-switch control. The achievement forecasts the time when mainline compressor stations will be equipped to operate entirely by remote control from a central source of micro-wave or by direct line.

Under development for some time through joint efforts of Northern Natural and the Cooper-Bessemer Corporation, a unique automatic control now programs all the functions of starting the engine prime mover and putting the compressor on the mainline, according to technicians from Northern Natural and Cooper-Bessemer who headed the control development program.

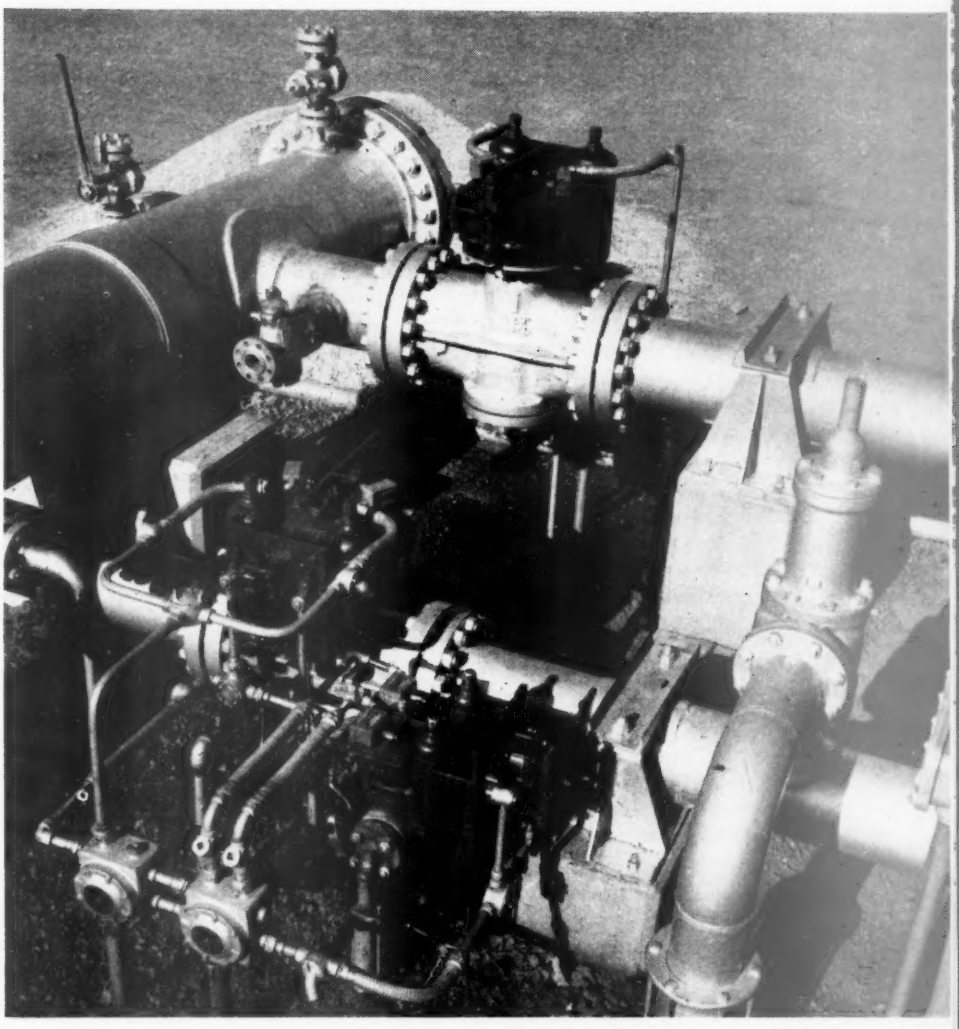
The new development in control design now combines the economies of



Operator at control panel designed for automatic single-switch operation



Forward end of compressor unit. At right is by-pass valve installation, which has valve operator



Valve operators are used on manifold blowdown, discharge, and suction valves. The relief valve is consolidated. All valves are plug type

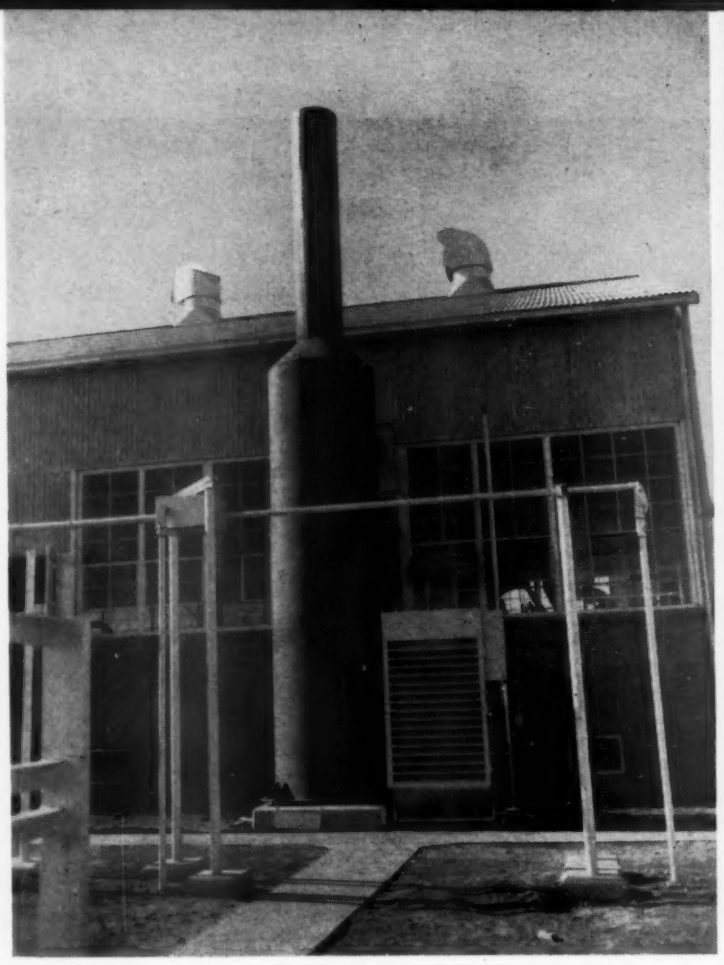
reciprocating compressor machinery with the advantages of complete automatic operation. Marked savings in operating costs will assist reappraisal of pipe line programs for selecting compressor equipment for new stations and expanding existing capacity.

These operating benefits are attained with simpler circuits and fewer steps in sequence. The net result is easier procedure for putting on and taking compressors off the line. The achievement couples the fuel economies of reciprocating machinery with operating advantages of automatic control for cross-country transmission service.

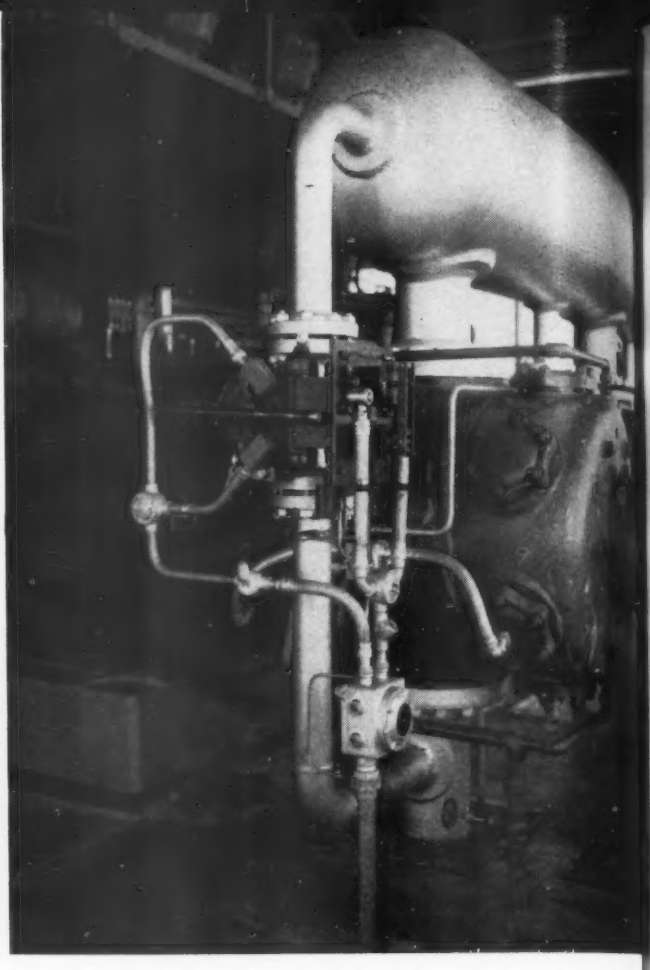
Almost daily improvements in automation of compressors are being perfected by engine and compressor builders. One of the more recent to be reported is on the Gulf Interstate line where semi-automatic control of reciprocating engine driven compresors has proved highly satisfactory. The Gulf Interstate in fact is recognized for having one of the lowest operating costs for its type of transmission service.

On the Gulf Interstate, automatic starting of the engine and cutting in the compressor into the line are hand-

XUM



Compressor exhaust and air intake



Closeup of valve operator on by-pass between suction and discharge surge tanks

led as two separate functions. Northern Natural's Mullinville installation advances the automation one step by combining both starting and loading functions into one continuous control sequence.

The inherent operating efficiencies of reciprocating engines are the basic reasons for the savings being realized in mainline station operating costs. Fuel cost is said to be 75 per cent of turbine-driven compressors. Simpler operation and maintenance effect further reductions in operating costs.

Panel Description

The automatic control panel that programs the sequence of operations to start and load the engine has four basic control circuits. These are:

The engine starting circuit
Valve positioning circuit
Alarm circuit, and
Shut down circuit.

The control panel can be set for "automatic" or "manual" operation.

Automatic Operation

On "automatic," the single-switch actuates a sequence of controls, each timed and interlocked to prevent continuance of the cycle program in event of malfunctioning of any phase.

As the starting switch is turned:

Auxiliary pumps are started.

Engine jacket water pressure and lube oil cooling water pressure build up.

When the water pressure reaches a predetermined value, the unit pressurizing valve opens, purging compressor unit piping through the blowdown valve. The blowdown valve closes after a preset time.

The discharge valve opens as the pressurizing valve closes. When the discharge valve is fully opened, starting air is applied to the engine.

Purging time of 8 seconds is allowed in rolling engine on air before ignition is switched on. Once ignition is established, the engine fuel gas control solenoid opens. At this point the fuel gas valve opens, the engine fires and speed increases to a preset valve under governor control. The starting air is then turned off.

After running at this speed for a set time, the line suction valve starts to open, the by-pass valve begins to close. Engine speed is then regulated to 240 rpm and the engine is fully loaded.

Starting the engine and putting the compressor on the line takes between 3 to 4 minutes.

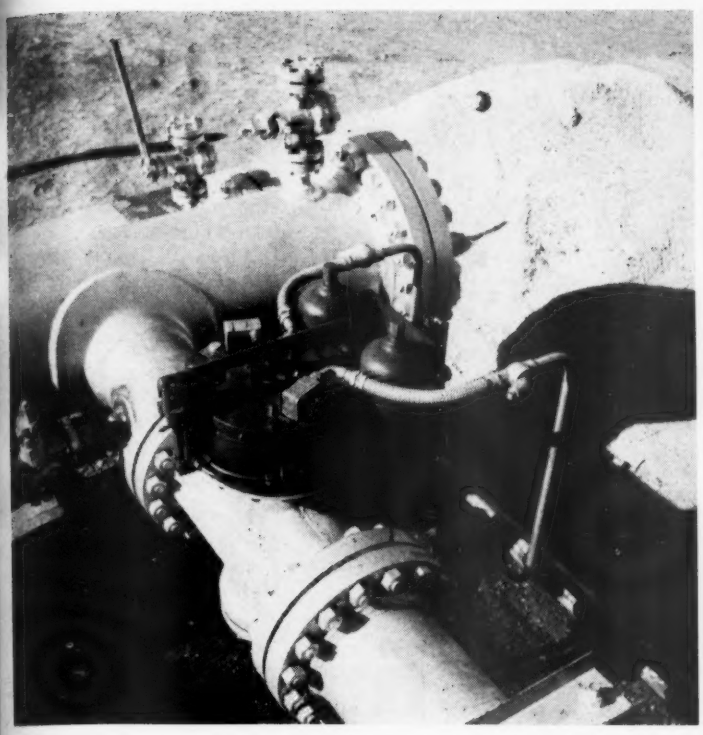
To shut down the compressor, the control panel switch is turned to *"off"* position. The control pressure solenoid closes to shut off the fuel to the engine permitting the engine to roll to a stop. As engine scavenging pressure drops, the line suction valve closes, the discharge valve closes, the by-pass valve opens and the blowdown valve opens. The ignition is cut off by a drop in scavenging air pressure. Water pumps stop at this point.

Remote Manual Control

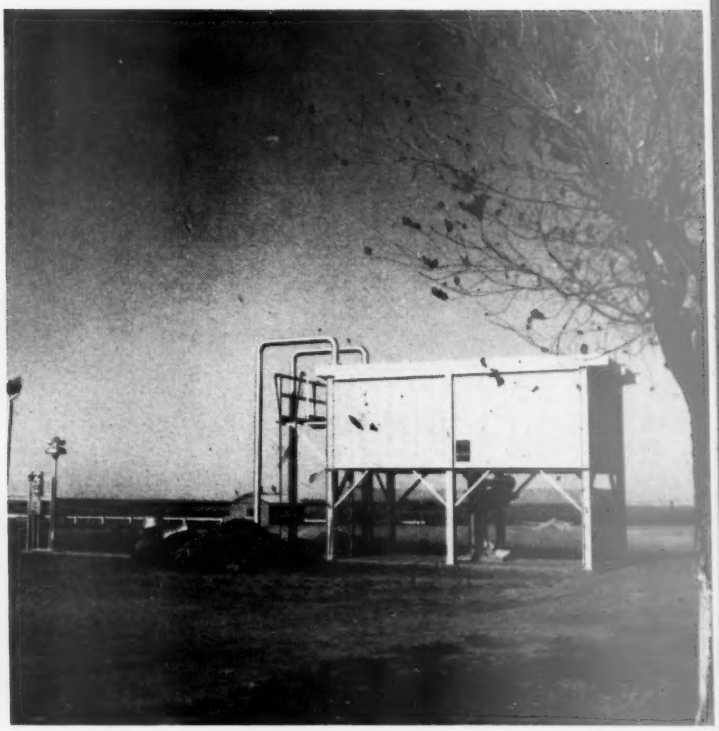
Provisions for remote manual control of line valves are provided by positioning the control valve switch from

The Author

Edgar N. Sampson is an electrical engineer with the Cooper-Bessemer Corporation, Mount Vernon, Ohio. A graduate of Ohio State University with a degree in electrical engineering, he was employed as supervisor of electrical maintenance and construction with a foundry prior to assuming his present position in 1953. He is a member of Kiwanis and the National Society of Professional Engineers.



Valve operator on suction valve



Jacket water cooling tower equipment

"automatic" to "manual." The line valves are then positioned by individual manual control switches from the panel itself.

When starting the engine on "manual" operation, the master switch is turned to "start" and released to "run," to initiate the auxiliaries. Discharge and blowdown valves are positioned by individual switches. Only when the discharge and blowdown valves are correctly positioned does the engine roll on air through its purge time and come into running condition. The loading of the compressor on the line is done by individual switches on the panel.

To remove the compressor from the line the master switch is turned to *"stop"* position. This shuts down the engine. Line valves are positioned by individual switches. The blowdown valve is interlocked so it will not open until the discharge valve is completely closed, which is also true in automatic operation.

On "manual" or "automatic" operation, individual valve control switches have pilot lights for indicating line valve positions. When line valves are traveling between open and closed positions both pilot lights are on. During "automatic" operation, pilot lights provide visual check on engine start procedures and line valve position.

Pilot lights for auxiliaries "on," ignition "on" and gas "on" are mounted above the master switch. Alarm and shut down pilot lights are mounted directly below respective gages.

Gages and equipment provided on the control panel indicate starting air and control air pressure, with control air low-pressure alarm; jacket water pressure, with low pressure alarm; lube oil temperature, with high temperature alarm; lube oil pressure, with low pressure alarm, and low pressure shut down; fuel gas pressure; and high temperature shut down.

A tachometer for engine speed has an over speed shut down pilot light. The exhaust temperature pyrometer is provided with temperature alarm.

Pilot lights are provided for high discharge gas pressure alarm and shut down. An additional pilot light reports a broken compressor discharge valve, and a switch which will detect the exact valve. A 3-button control station with pilot lights for the radiator fans is panel-mounted on the same control board.

Air starting of the engine is accomplished through an interlocking circuit, of the line valves and pressure control switches of auxiliaries, to a pilot solenoid. Engine ignition is controlled by scavenging air pressure switch that actuates a purge time relay and then the ignition relay. The gas pilot solenoid is operated through the ignition relay.

Scavenging air pressure of the engine shuts off the starting air and interlocks and triggers the line valve positioning circuits.

Control panel alarms provide both visual and audible indication. The horn is silenced by actuating a push button on the panel. Visual alarm remains in effect until the trouble is corrected.

Shut down circuits cover the stopping of the engine and proper functioning of the line valves to "down" position in event of low lube oil pressure, high jacket water temperature, engine overspeed, or high discharge pressure.

The circuits give visual and audible indication for any particular malfunctioning that causes the shut down. The visual shut down indication remains "on" until the master switch is turned to the *"stop"* position. Circuits are made to prevent restarting the engine without first turning the master switch to *"stop"* position.

A by-pass, or unit pressuring valve, is provided around the main suction valve to purge and pressure the unit before starting. The blowdown valve closing circuit is interlocked through the control of the unit pressuring valve.

The discharge valve opening is interlocked through closing of the blowdown valve and has a time delay for pressuring the compressor unit.

The unit pressuring valve, bypassing the suction valve, is closed through an interlock with the discharge valve opening circuit. This means that the engine must start with the blowdown valve and the suction valve closed, the bypass valve and discharge valve open.

The reciprocating engine-driven compressor at the Mullinville station is a 2000-hp Type GMWA Cooper-Bessemer. Controls were engineered by C-B built by Kirkhof Electric, Grand Rapids, Michigan. The station addition was constructed by Foor Engineering Company, Oklahoma City. * * *

XUM

Sea-going pipeliner waits at UGPL platform to be picked up by incoming boat, the 43-ft motor launch "Roustabout"

pipelining by boat

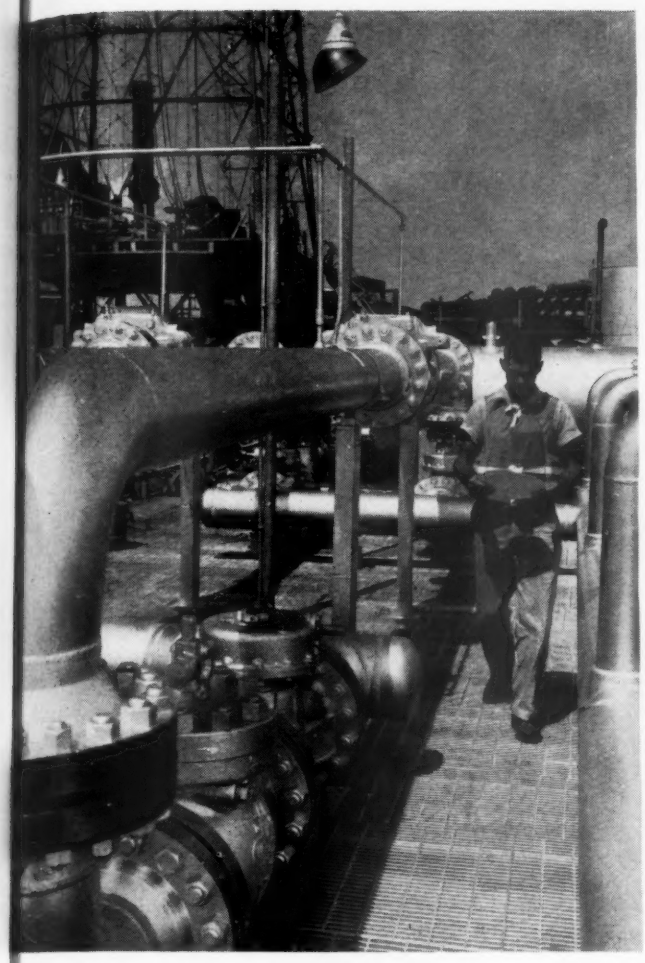
KEEPS UGPL OFFSHORE FACILITIES OPERATING

Mobile radio units are installed in each boat for communication with shore, platforms, and other boats. Two-way radio speeds up work, is comforting link with land, operates 'round-the-clock

TWICE a week, fifty-two weeks a year, a speed boat eases out of the United Gas Pipe Line's marine slip at Morgan City, Louisiana, and heads seaward for a 100-mile journey into the Gulf of Mexico where UGPL's "seagoing pipeliners" will visit the various offshore platforms where the company purchases gas, checking installations and changing charts on the purchase meter stations.

Unique—yes. But to the crews who make these semi-weekly chart runs, it is just another part of the work necessary in operating and maintaining a marine pipeline system that brings some 100,000,000 cu ft of natural gas per day to United's system.

The crews operate out of Morgan City, chief base of UGPL's offshore



Frequent inspections are made of equipment on platforms

Bi-weekly trips enable the marine pipeliners to change charts on each platform where gas is delivered

operations since the facilities were placed in operation three years ago. Here are located section headquarters, including office, warehouse and pipe yard, and the boat slip, and an amphibian plane ramp on Bayou Boeuf.

The offshore pipeline system, which now comprises more than 27 miles of underwater line ranging from 10 to 20-in. in diameter, provides one of the principal sources of supply for UGPL's 30-in. main line from South Louisiana to Kosciusko, Mississippi. The 20-in. line, constructed in late 1951, was built of ¾-in. wall pipe enclosed in heavy concrete and somastic jackets, first large diameter pipe line ever laid into the Gulf of Mexico.

Terminus of the 20-in. section is United's platform in Block 32, which serves as a junction for all offshore facilities. From here, two 10 and two 14-in. lines reach out to connect producing platforms.

On each of the platforms in Blocks 32, 33, and 51, United has purchased meter stations to measure the volumes of gas being delivered. Each of these must be visited twice weekly to make chart changes.

Three craft make up the fleet used by the seagoing pipeliners. Flagship of the group—and largest boat in the New Orleans district of UGPL—is the 75-ft "Driller." Others are the "Dispatcher" and the "Roustabout," a pair of 43-ft cabin speedboats, powered by 165-hp marine diesel engines. All are twin-screw craft.

The two speedboats cover the distance between Morgan City and Block 51 in approximately one hour and 45 minutes, cruising normally at a speed of 22 to 26 mph, approximately twice that of the "Driller." Because of their speed advantages and shallow water design, they are used for most chart trips. In bad weather, when rough seas make it safer in a larger boat, the 'Driller" makes the offshore run.

The "Driller" is also used when pipeline personnel remain offshore for a night—and sometimes several nights—to complete special work. It has a complete galley, below-deck sleeping quarters, and other facilities for a working force of 8 to 10 men, plus ship's crew of captain, engineer and cook-deckhand.

Communications are supplied by a two-way radio system that plays an important part in offshore operations. Transmitters and Burns and Houma provide 24-hour contact with mobile units in each of the boats. The radio speeds up work and provide the men at sea with a comforting link with land.

In addition to the semi-weekly chart runs, other periodic trips are made to the offshore areas. Once a month a meter inspector checks the metering equipment. Routine maintenance such as painting must also be done at regular intervals. From time to time, the speed boats make inspection trips along each section of line, watching for tell tale surface bubbles that might indicate pipeline leaks. * * *

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FULLY *Automatic!*

. . . Latest COOPER-BESSEMER GMWA

Compressor Station

Development . . .

NOW, by merely energizing a *single*-switch control, a 2,000 hp Cooper-Bessemer engine-driven GMWA compressor is started and put on line. That's exactly what takes place at Northern Natural Gas Company's mainline station in Mullinville, Kansas . . . worked out jointly by Northern Natural and Cooper-Bessemer.

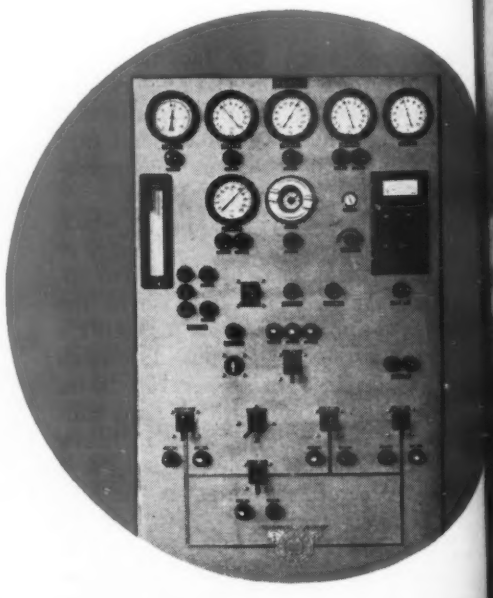
This will be welcome news to all who are familiar with the intense competition between different methods of moving gas through pipe lines. It means you can now continue to experience the greatly superior fuel economy of the reciprocating gas engine and at the same time benefit from all the other economies claimed for competing equipment.

Impressive results at Northern Natural are typical of the Cooper-Bessemer development work that continues day after day. Next time you need heavy-duty engines or compressors, first find out about the *newest* advancements being offered by one of America's oldest engine builders . . . Cooper-Bessemer. Detailed information and complete-line bulletins are readily available from the Cooper-Bessemer office nearest you.

This interior view of the station shows the 2,000 hp Cooper-Bessemer GMWA, and in the background the control panel used for automatic single-switch compressor operation.

Shown here from the compressor cylinder side is the Cooper-Bessemer GMWA compressor in the Mullinville, Kansas Station of Northern Natural.

Here's a close-up of the control panel for automatic single-switch operation of the 8-cylinder GMWA reciprocating compressor.



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Compressors

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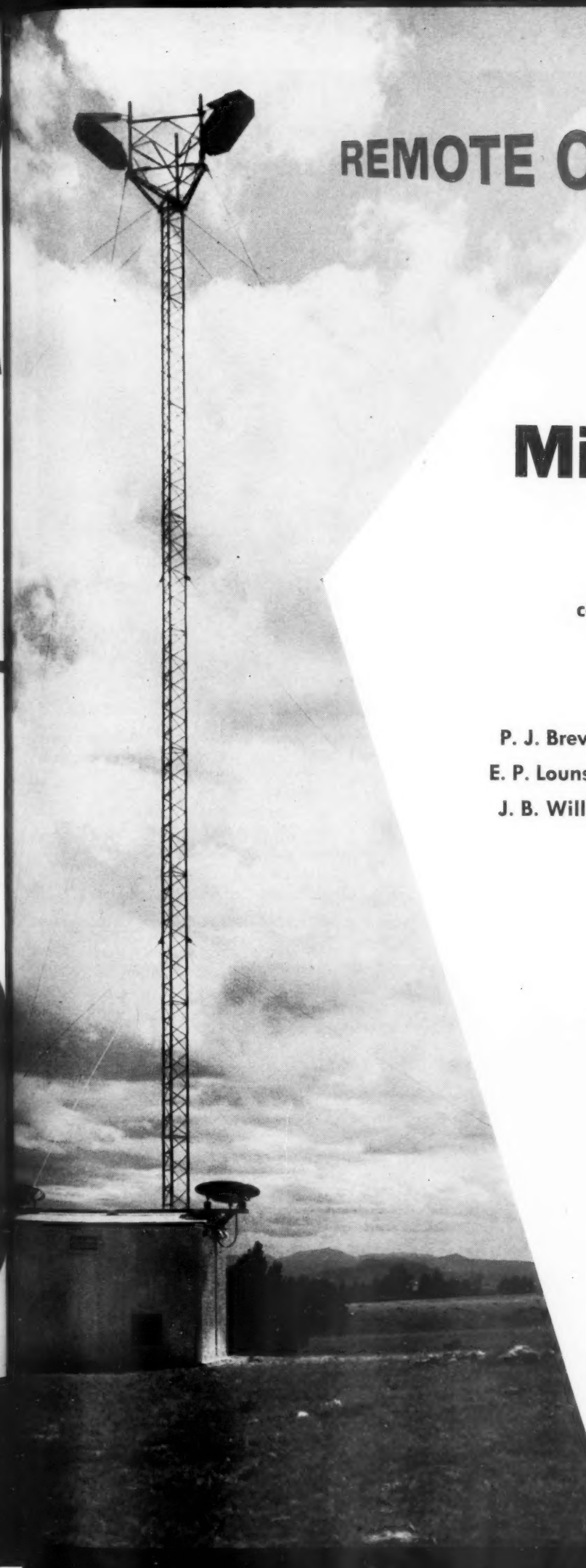


REMOTE CONTROL by Microwave . . .

. . . one dispatcher at central point controls and supervises Platte Pipe Line's entire 1000-mile system

P. J. Brewster
E. P. Lounsberry
J. B. Williams

ONE OF THE MAJOR REQUIREMENTS in the operation of a pipe line is the coordination of the parameters of flow and pressure at widely separated points along the line. The most efficient way of solving this requirement is by the application of centralized supervisory control to operate the various valves and pumps that control these parameters.

Centralized supervisory control is a system whereby one operator (dispatcher) at a central location receives a continuous indication of the operating condition of the equipment along the line and can, by remote control, change these conditions at any time. Such a system requires a reliable communication system, closely integrated with the pipe line, for transmitting the supervisory and control information to the control center and the remote locations. In addition, the system must provide numerous channels for handling other types of communication requirements such as telephone, teletype, and telemetering. Microwave radio relay with its large channel capacity provides an ideal transmission medium for such a communication system.

The largest pipeline installation of supervisory control over a microwave

EXCLUSIVE

system has been installed by Platte Pipe Line Company. On its 20-in. crude line extending 1000 miles from Casper, Wyoming, to Wood River, Illinois, are 12 pump stations, each of which contains equipment controlled and supervised remotely by the dispatcher at Kansas City, Missouri, 300 miles west of Wood River.

At Kansas City, and at each of the pump stations, is located a microwave relay station with associated frequency division multiplexing equipment for dropping out and inserting the supervisory control signals and other communications channels. The microwave stations at intermediate points function as repeaters for relaying the signals from both directions. In addition there are 31 feed-through repeater stations for relaying. At these stations only the service channel and microwave alarms are inserted or dropped out.

The nerve center of the supervisory control system is the dispatcher's console at Kansas City. This console is shaped like a large "V" and is approximately 20 ft in length. Each arm of the console has a sloping panel that contains escutcheons on which are mounted the indicating lamps and switches for the individual and common supervisory control operations. The escutcheons for the individual control operations for each station are grouped together below the station nameplate, and those for functions that are common to a station or the whole system are mounted along the top of the panel. The microwave fault alarm indicating lamps are mounted above the sloping panels.

The center section of the console is a work area, or desk, with the instantaneous telemetering and tank level meters mounted on the upright rear portion. Telephones for the dispatcher's talking circuit are also located on the desk. The blackboard on the wall in front of the dispatcher provides a flow diagram of the complete 1000-mile pipe line.

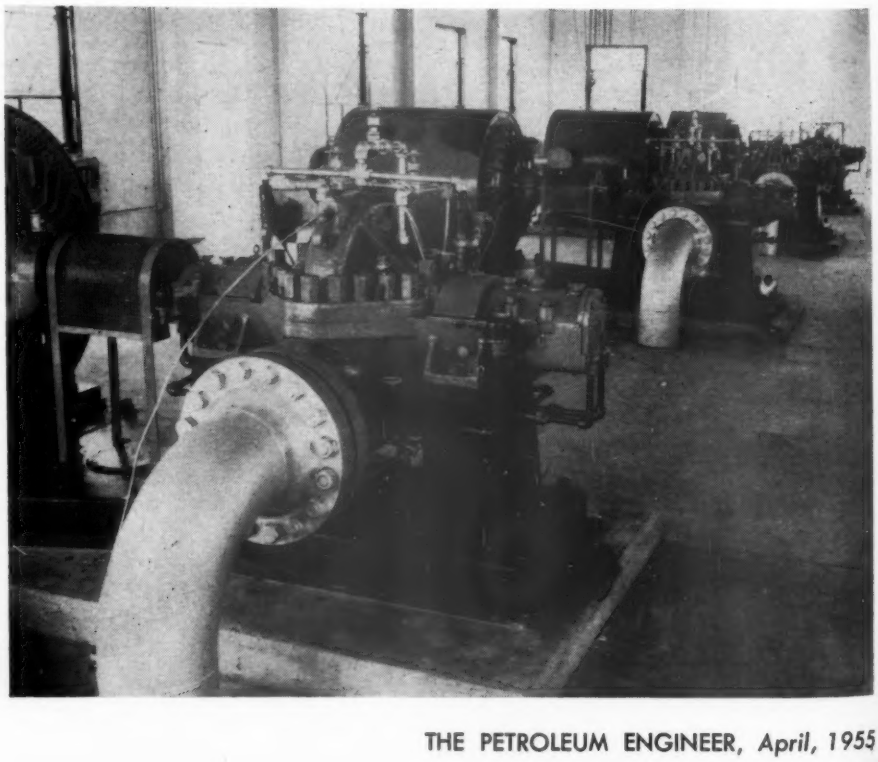
Adjacent to the console and in full view of the dispatcher are four cubicles that house the control relays, tone generators, tone receivers, and continuous telemetering recorders. Similar cubicles located at each pump station contain remote station relays, tone generators and tone receivers.

The functions at the 12 pump stations that the dispatcher is able to control from Kansas City are:

(1) Start and stop a pump motor;
(2) Open or close a main line or bypass valve;
(3) Tank level measurements;
(4) Discharge pressure readings;
(5) Shut down a complete station;
(6) Raise or lower pressure.

Platte Pipe Line Company control headquarters at Kansas City, Missouri, showing Eastern and Western division control consoles with telemetering recorders mounted on walls

Interior of pump station showing equipment, six functions of which can be controlled from Kansas City



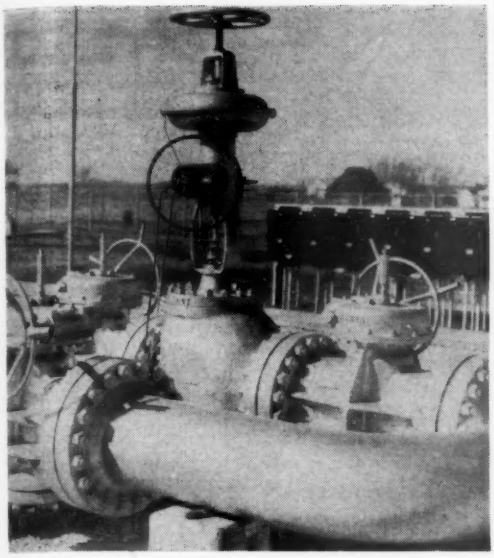
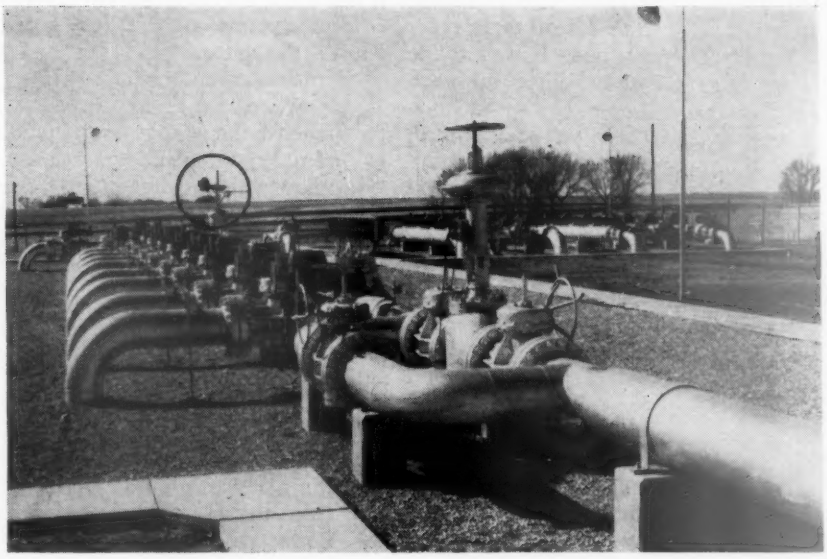


Photo shows pump station with circle indicating attached automatic control device for remote operation of rate of flow



Circle indicates the controller used to raise or lower pressure by remote microwave control

These six functions are presently being used. Each pump station's equipment, together with the centralized control station equipment, is capable of expansion to a total of 12 functions. These functions are performed by one of 3 types of control operations:

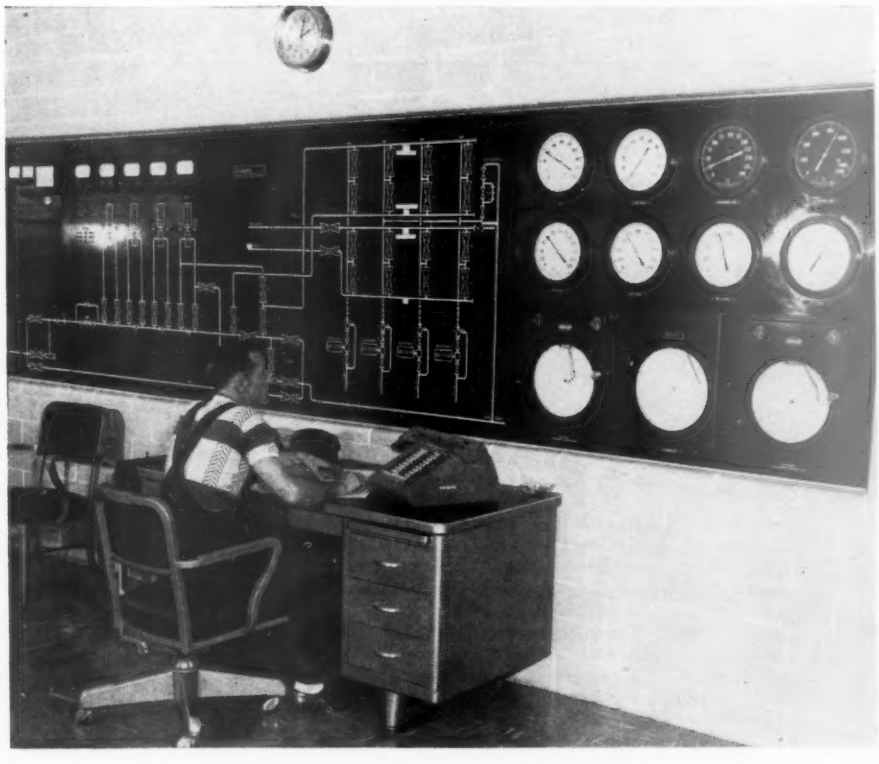
1. *Binary type:* In which the controller equipment can be changed from one operating condition to another, such as open or close a valve, start or stop a motor.
2. *Selection type:* In which the controlled equipment is triggered into operation, such as initiating the operation of the sequencing controls to shut down a pump station, or the operation of a selection circuit to connect an "instantaneous" telemetering transmitter to the common reporting channel.
3. *Positioning type:* In which the setting of the controlled device can be continuously controlled such as the operation of a pressure controller to raise or lower the line pressure to a required value.

THE SUPERVISORY CONTROL SYSTEM employs a coded sequence of four audio frequency tones to perform a remote control function. Five tones are available in case future expansion requires the control of more functions at more stations. Any tone can be used more than once in the sequence but not consecutively, thus a large number of selection points are provided. Each selection point uniquely selects and operates one control function. The tone pulses are four-tenths second duration with a one-tenth second separation.

When a control function is initiated by the dispatcher, the tone generators for the four tones in the sequence are connected to four segments on a switch which is driven by a synchronous motor. The tone generators, having a common output, are turned on in sequence as the switch rotates. The output of the tone generators are fed to a carrier channel for transmission over the microwave system to all remote control stations in the respective section.

Each remote control station contains frequency response units for all five tones. As each tone of the sequence is transmitted the corresponding frequency responsive unit relays at all remote stations are activated. The response unit relays have their contacts arranged in a "tree type" circuit to effect the closing of an interposing relay, operation of which initiates the control function and also causes a tone signal to be transmitted back to the control center to indicate that the function has been initiated. This selective

Pump station control room at Salisbury, Missouri, repeater station showing pipe line flow chart and metering equipment



function is the same for all three types of control operations, however the supervision functions differ for each type.

Assume that a binary type of control operation, such as starting an idle pump motor, is to be performed. The initial condition existing on the control panel will be, control toggle switch in the *"stop"* position, and *green* lamp lit. When the control toggle switch is thrown to the *"start"* position, the *white* lamp is lit and the circuits for the"start" code sequence will be set up. Actuation of the *operate* switch will cause the coded tone sequence to be transmitted and when the sequence signal is completed an *amber* lamp on the common indicator panel will light. The operator then releases the *operate* switch.

When the sequencing pump station relays for the selected function operates, the *blue* "operation initiated" lamp will light, the *white* lamp will extinguish, and the *red* "start" lamp will light. This leaves both the *green* "stop" and *red* "start" lamps lighted, indicating that the starting mechanism is in operation.

When the motor is finally started, an indication check cycle will be initiated at the pump station causing the console station nameplate to light and also extinguish the *green* light. The reverse operation of stopping the motor is similar. The functioning of the supervisory control equipment for valve operation of *"open"* and *"close"* is the same as for motor *"start"* and *"stop."*

TANK LEVEL TELEMETERING IS AN example of the selection type of control. It is initiated by actuating the tank level operate switch and holding it until the amber light is lit. This type of measurement operates as follows:

When the four tone sequence reaches the control equipment at the remote station it actuates a stepping relay which steps one step and in return starts a scanning device operating, this scanner scans the first of the three local tank level meters which is calibrated 0 to 30 ft. The device causes a tone to be transmitted to the control station; the receiver at the control station upon reception detects this signal, converts it to d-c current which is applied to a meter on the console and this meter is calibrated in feet to conform to the meter at the pump station.

When the received signal disappears at the control station a signal tone is automatically transmitted to the pump station stepping the selector switch another step thereby causing the scanning device to transmit a second tone pulse conforming to the reading on the second meter which records 30 to 60 ft.

This reading is recorded on a like meter at headquarters, the third meter is scanned at the remote station resulting in a control station recording of 0- to 12-in. range.

If a tank should be filled to thirty-four feet and eight inches the meter readings at Kansas City would record the thirty-four feet on the second meter calibrated 30 to 60 ft and the inches on the third or 0-12-in. meter.

Another example would be a reading of twenty-four feet, in this case the twenty-four feet would be recorded on the 0-30-ft meter and no reading on the other two. The scanning device has a meter of the same internal impedance as the local recording device resulting in a headquarters reading proportional to the pulse length.

When tank level readings are requested, the control equipment automatically switches the scanning meter into the circuit, locking out any local control operation for the duration of the three scanning cycles. When the third scan is completed both the pump station equipment and control station equipment, except the meter reading at the control station, return to normal. Only one set of meters is available for tank level telemetering, therefore the previous reading must be cancelled before another tank level can be read. This is done by placing the operate switch in the downward or cancel position and holding until the amber lamp again lights.

Supervisory control for telemetering of discharge pressure, on an "instantaneous" basis, functions the same as tank level gaging with exception that the requested reading is transmitted continuously and recorded on a 0 to 1500 psi meter until cancelled.

THE FUNCTION OF RAISING OR LOWERING line pressure by means of a remotely controlled pressure controller is an example of the positioning type of control. In this case the direction of change and the final position of the pressure controller can be controlled. The selector switch is set to the direction in which it is desired to change the pressure, that is "raise" or "lower."

Actuation of the operate switch will cause an interposing relay at the remote station to operate, thus starting the pressure controller to change the line pressure in the desired direction. The pressure controller will continue to run as long as the operate switch is held and will stop when the switch is released. The pressure controller will hold the line pressure at a value corresponding to the position in which it stops.

It is necessary that the discharge pressure at the remote station be monitored by "instantaneous" telemetering which is set up before the pressure change function is started. The function is "fail-safe" in that the controller will stop instantly if the signal to the remote station is interrupted.

An "indication-check cycle" feature is provided whereby individual control function lamp indications on the control panel can be compared with controlled equipment conditions at the remote stations. Any discrepancy that may exist is indicated by a change in the lamp indications. The indication

The Authors

Lounsberry

Williams

Brewster

Eugene Lounsberry joined Philco Corporation, government and industrial division, in March, 1951, as a communication project engineer. He was formerly an automatic switchboard design engineer for North Electric Manufacturing Company, and resident inspector of naval material at Mansfield, Ohio. Lounsberry is a reserve Lieutenant Commander, USNR, and a graduate of the University of Notre Dame with BS in electrical engineering.

James B. Williams joined the government and industrial division in August, 1942, as a radar design engineer. In 1949 he was in charge of development and production engineering of microwave communication and multiplex equipment, and in 1952 he was appointed executive engineer in charge of communication and broadcast products. Williams is a graduate of the University of Kentucky with BS in electrical engineering.

Preston J. Brewster joined government and industrial division in October, 1951, after being associated with Federal Telephone and Radio Corporation from 1942 to 1951. During World War II he assisted in design and evaluation tests of a number of radar projects, including ground control approach. An affiliate of the AIEE, Brewster was project engineer of the Platte Pipe Line microwave installation for Philco Corporation.

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for remote indication and control
of pressure and temperature

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ElectroSyn is unique in its simplicity of design, reliability and the minimum maintenance it requires. Without complex circuits or electronic tubes, it provides an exceptionally high output signal, electrically transmitted, which makes possible accurate remote readings of pressure and temperature. It is suitable for use with multi-point indicating or recording systems.

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For dependable microwave operations, the top of the tower must be held steady under all weather conditions. The unique bridle guying and superior structural features of Emsco microwave towers assure minimum torsional deflection . . . minimum maintenance costs.
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Another typical Emsco microwave installation on Texas Eastern's natural gas pipeline system.

check can be initiated from either the remote station or the control station. It is initiated from the control station by the operation of the indication check switch for the desired remote station.

Operation of this switch will cause a code sequence to be transmitted to start a stepping switch distributor at the remote station. Once started, this switch will be automatically stepped around until it returns to its home position. As it steps it causes a series of tone pulses, consisting of two frequencies, to be transmitted to the control station.

The first portion of this series operates the distributor selector at the control station to select an indication distributor corresponding to the station transmitting. Once selected this distributor will step in synchronism with the remote station distributor.

The second portion of the series of pulses sent from the remote station will indicate the position of all the controlled equipment at the station. The control distributor will check the corresponding indicator lamps on the control panel and make any changes necessary to bring them into compliance with the condition of the controlled equipment.

If the remote station and control station distributors accidentally get out of synchronization the entire group of lamps for that station will be blacked out to prevent false indications. To reestablish the indication the operator has only to originate another indication check.

AN INDICATION CHECK CYCLE will be originated at the remote station whenever a controlled equipment is operated either by remote or local control. In this case the distributor cycle is started by the complete operation of switches or sequencing relays of the controlled equipment.

A LOCK-OUT FUNCTION is incorporated in the equipment to prevent two or more remote stations from reporting simultaneously. Remote stations are identified at the control station by the number of pulses that precede the indication report, i.e., most westerly station 2, next 3 etc. When any station starts a reporting cycle and the required pulses reach Kansas City, a tone pulse is transmitted to all pump stations, allowing the lowest digit station to continue and holding the remaining ones until that one is completed.

Upon completion, the next lowest digit reporting station will continue. This feature allows remote operation of more than one station at a time, in other words a function may be initiated at one station, then another, without waiting for the indication cycle to return. * * *

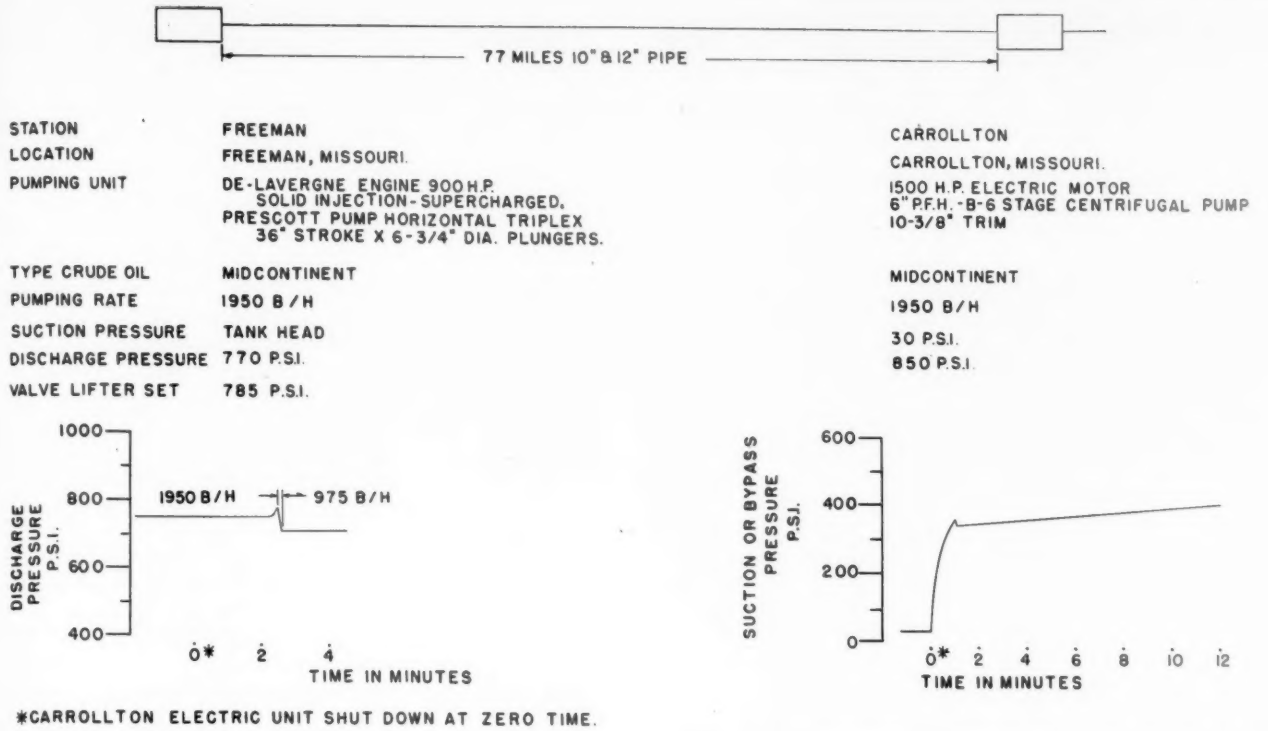


FIG. 1. Typical operation of reciprocating pump valve lifters in pipe line (closed system operation).

Applied to Closed System Operation . . .

Reciprocating Pump Valve Lifters

. . . permit automatic control of pump output

T. S. Llewellyn and M. T. Nigh

AUTOMATIC control of the output of reciprocating pumps in pipe line service has been a perplexing problem. Discharge bypass valves have been used, but these are restricted by range and positioning problems, as well as the inherent power loss caused by throttling. Engine speed regulation is a successful method but is limited by mechanical factors.

This article explains a method of control that can be called internal bypassing. With this method, one of several suction valves in each pump cylinder of a conventional reciprocating pump is converted into an internal bypass valve. The valve is held in either an open or closed position. An auxiliary valve is used for pumps having a single suction valve in each fluid cylinder. When closed, the pump operates normally; when open, the fluid displaced by the action of the plunger flows back and forth through the valve without being discharged from the pump. The advantages of this method are unique. Flow is at a relatively low rate through the open valve. No throttling or intermediate positioning of the valve is required. Erosion of the valve parts is not encountered and wasted power is insignificant.

It is acknowledged that the principle of lifting suction valves to vary output has been applied to constant speed reciprocating air compressors in some industrial processes, but it is believed that the application of this principle to crude oil pumping equipment has never before been attempted.

Application In Operation

Until recent years the conventional method of pumping oil has been to pump from tanks at one station to tanks floating on the suction lines of pumps at the next downstream station. This is sometimes called an open system, whereby oil is pumped from station to station by increase and decrease out of tanks. The method has certain advantages, but economic considerations and simplification of pumping facilities have fostered a trend toward closed or tightline operations.

This type operation eliminates the high investment in tankage at each relay station, and also reduces evaporation losses. An additional advantage is the reduction in contamination or intermingling of crude batches of different quality. Also, closed systems may require that several pumping stations all discharge at identical flow rates. Upsets at any point in the system must be automatically adjusted for at other points to prevent excessive line pressures or cavitation of pumps on line.

Centrifugal pumps can be controlled

Paper presented at Petroleum Engineering Conference, American Society of Mechanical Engineers.

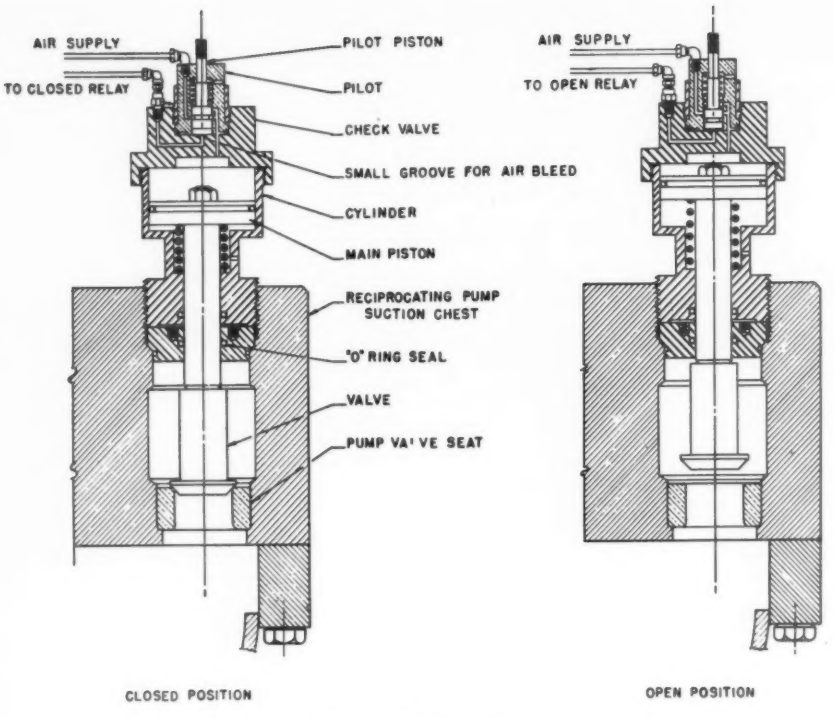


FIG. 2. Valve lifter

conveniently by throttling the discharge, but tightline operation with positive displacement reciprocating pumps presents a serious problem in automatic control. In the control method discussed here, the output of reciprocating pumps is regulated by holding a valve in the suction chest in an open or closed position. Using either suction or discharge line pressure change as an indicator for decreasing pumping demands, automatic pressure controls operate the valves as internal bypasses to reduce output or line pressure to safe levels.

Pump discharge rates can be decreased 50 per cent or 100 per cent in a matter of seconds without alterations in speed. Fig. 1 shows the actual discharge line pressure changes that occurred when half of a double-acting triplex plunger pump was automatically cut out because the line pressure had started to exceed the set point.

In this case, the pump was discharging 1950 bph at a pressure of 768 psi and the set point was 785 psi. The unit was operating on a closed system with a centrifugal pump 77 miles downstream. Some two minutes after the centrifugal pump shut down and the stream began bypassing the relay station, the pressure began to rise at the initial station until the set point was reached. This rise in pressure was immediately offset by the controls reducing pump output by one-half. If the pressure had continued to rise, the remaining three sections of the pump would have been cut out. It will be noted that the pressure did not go beyond the first arbitrarily selected set point.

Operating Principles

Valve Lifters. Fig. 2 shows cross sections of a valve lifter and pilot (manually reset three-way valve) assembly in opened and closed positions. Control instruments, operating from line pressure intelligence, actuate the valve by controlling the pressure under the pilot piston. When opening, the following sequence of events takes place:

a. A closed relay in the instrument circuit is opened by action of a pneumatic controller.

b. Air at 50 psi pressure, which has been trapped between the bottom of the pilot piston and the opened relay, is suddenly vented to atmospheric pressure. This air escapes faster than supply air can enter the pilot piston cylinder through a fine groove at the end of the cylinder wall.

c. Lack of pressure allows the spring to force the pilot piston downward. This seals the supply port and opens the exhaust port, allowing air under pressure to be released from the main cylinder.

d. With no air pressure on the main piston, the heavy spring beneath it opens the valve.

e. Displacement of the pump plunger circulates back and forth through the open valve, and flow through the discharge valves ceases.

f. When line pressure returns to a safe level, the opened air relay closes. The suction valve remains open, however, because supply air cannot enter the main cylinder through the port in the pilot valve.

g. The suction valve is closed by pulling outward momentarily on the pilot piston while main cylinder and relay air lines are pressurized.

For double-acting triplex pumps, the 3 fluid-end cylinders are manifolded to 1 air relay and the 3 power-end cyl-

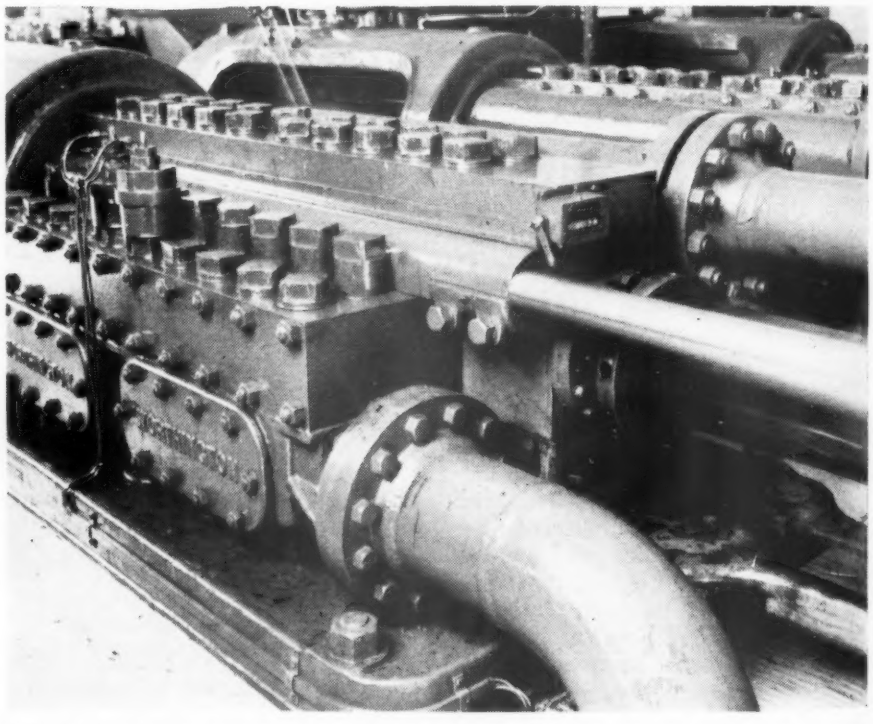
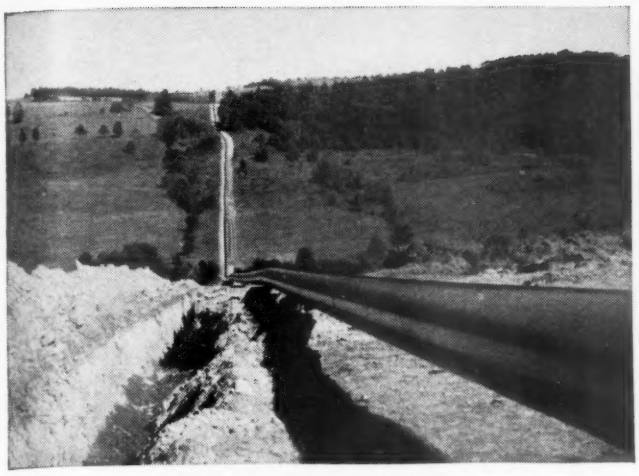


FIG. 3. Valve lifter installation on outboard section of 24-in. stroke double-acting pump



Pipeline laid over rugged terrain.

Pipeline ditch cuts through shale and rock.

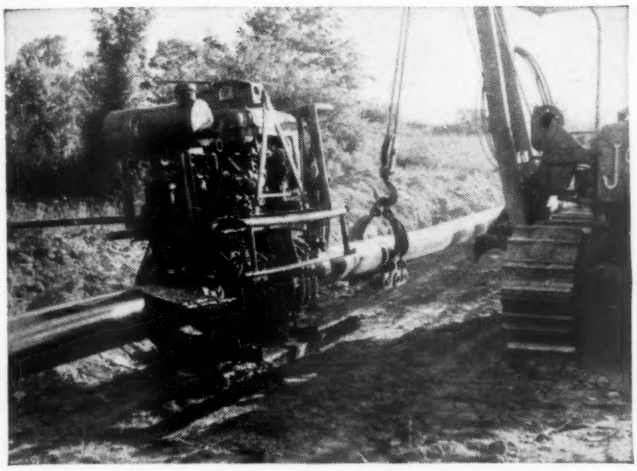


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FIG. 4. Cutaway of typical valve lifter assembly

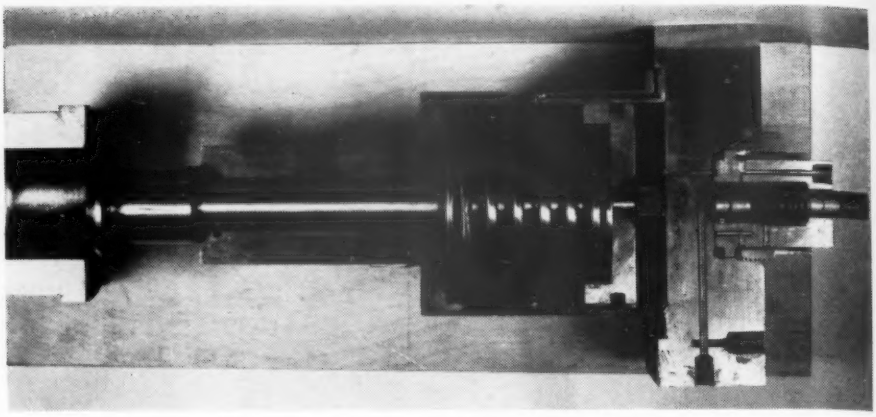
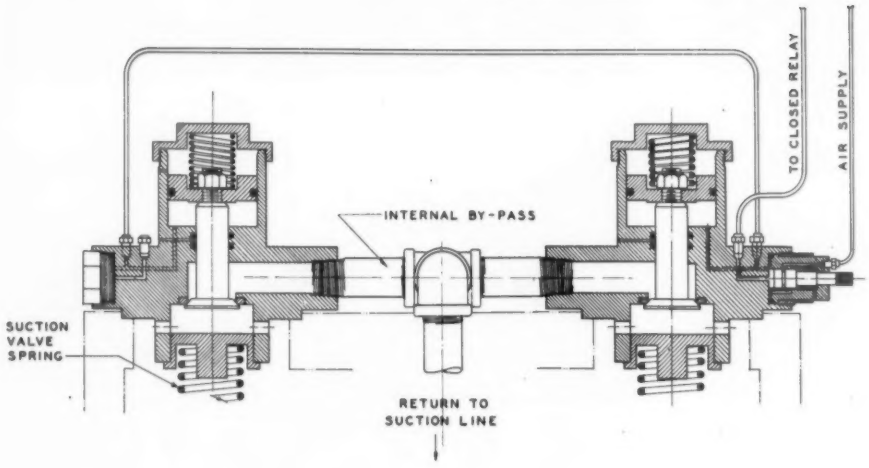


FIG. 5. Internal bypass for pump with single suction valve



inders to another relay. For double-acting duplex pumps, each side of the pump is connected to a relay. The relays are operated by the same controller through a differential of only 10 psi at the set point.

Fig. 3 shows valve lifters as installed in the outboard section of a 24-in. stroke double-acting triplex pump. The other two sections of this pump are similarly equipped.

Fig. 4 is a cutaway of a valve lifter designed for a triplex pump in which the port below the valve cover is large enough to accommodate most of the assembly. The pilot cylinder only extends beyond the valve port cover, giving this application a trim appearance.

A check valve is placed in the line from each valve lifter to the manifold going to the relay. This check prevents the closing of all open valves as one pilot piston is manually reset.

Fig. 5 illustrates the valve control as applied to pump cylinders having a single suction valve. In this case, the bypass assembly is housed in a valve cover that replaces the standard valve cover of the pump. The basic operating principles outlined previously apply to the unloading action of this valve.

The materials of construction are cold-rolled steel for suction valve cylinders, cadmium-plated steel for valve stems, and hardened steel seats. The pilot cylinder is hard brass and the piston stainless steel. The piston is lapped to the brass cylinder for sealing. The remaining seals are made with "O" rings.

For satisfactory operation the air relay must be able to exhaust the trapped supply air pressure to the atmosphere much faster than the extremely fine groove allows air to enter the chamber below the pilot piston. Pressure in this chamber must drop to about 15 psi to permit the small spring to push the pilot piston down. Also, the venting of the air over the main piston has to be rapid so that the valve lift within the period of one stroke of

FIG. 6. Instrument assembly in control cabinet

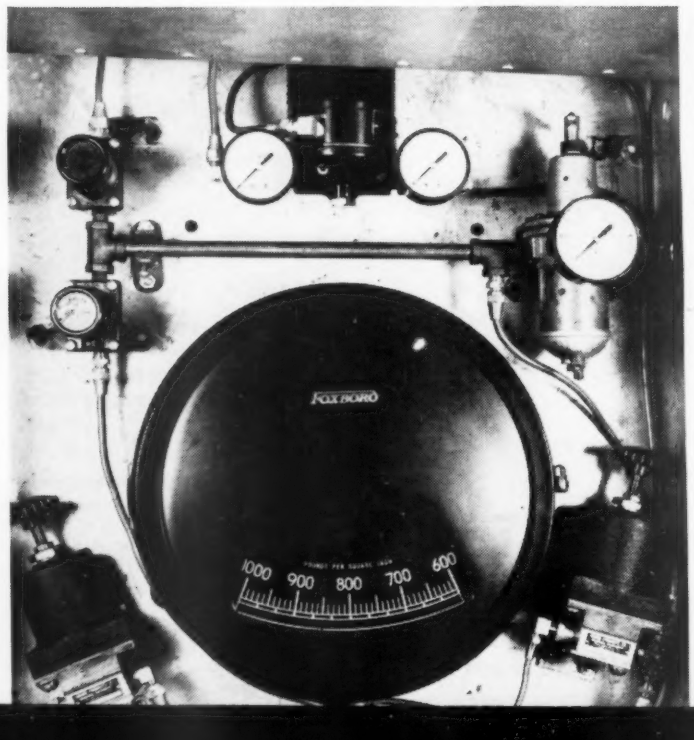
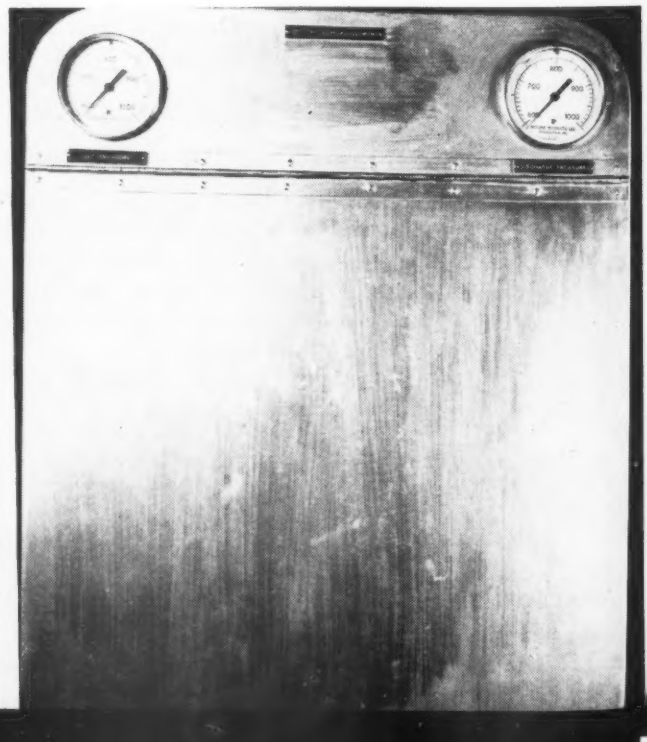


FIG. 7. Control cabinet



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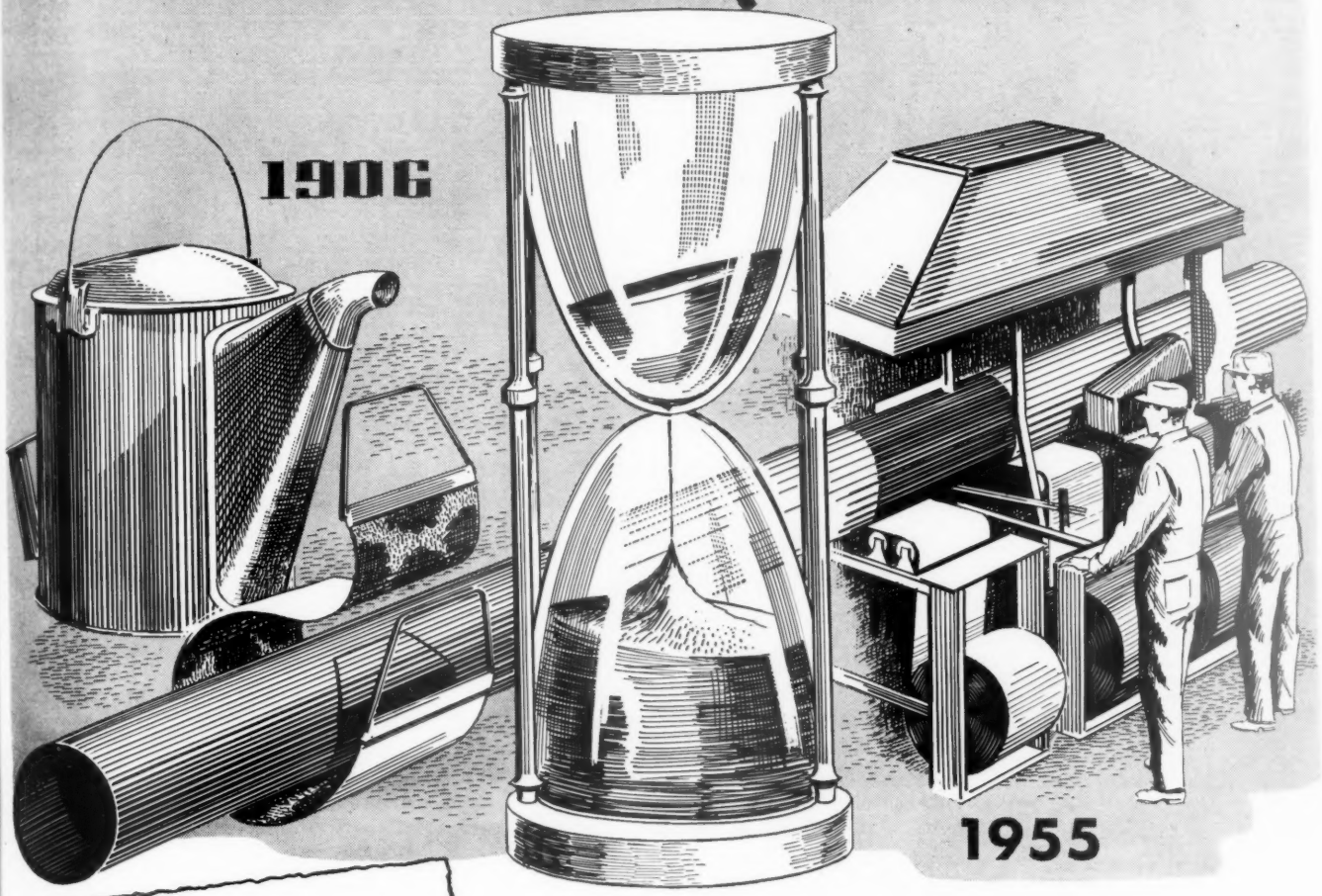

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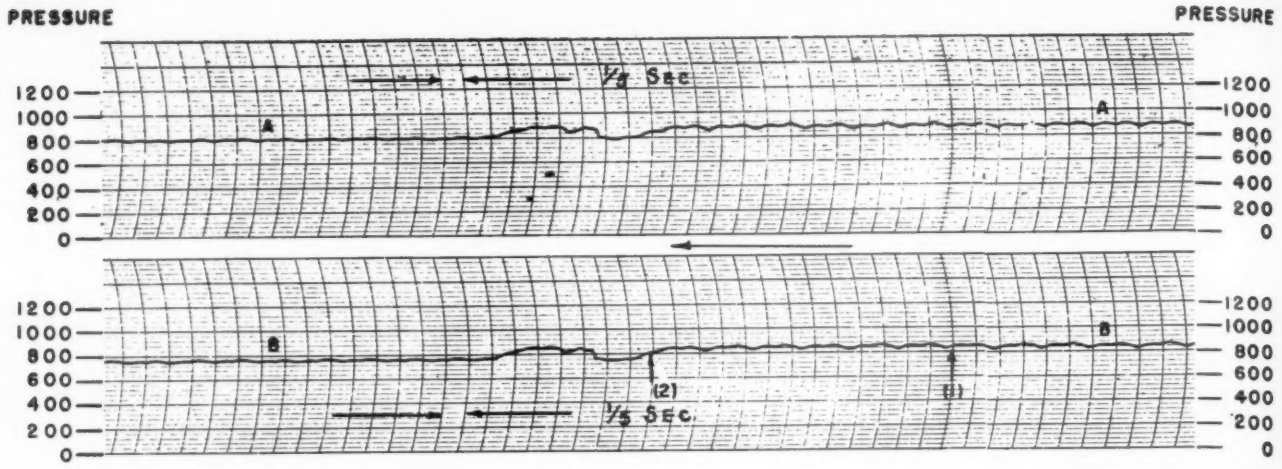


(A) PRESSURE TAP LOCATED ON DISCHARGE HEADER OF PUMPING UNIT.

(B) PRESSURE TAP LOCATED ON DOWNSTREAM SIDE OF CHECK VALVE IN DISCHARGE LINE.

PUMPING UNIT: FULTON ENGINE 1400 H.P. DUAL FUEL, WORTHINGTON PUMP 30" STROKE.

PIPELINE : FREEMAN TO LA-PLATA 129.99 MILES. EQUIVALENT 12" PIPE.

(1) AIR CONTROLS OPERATED IN CONTROL BOX.

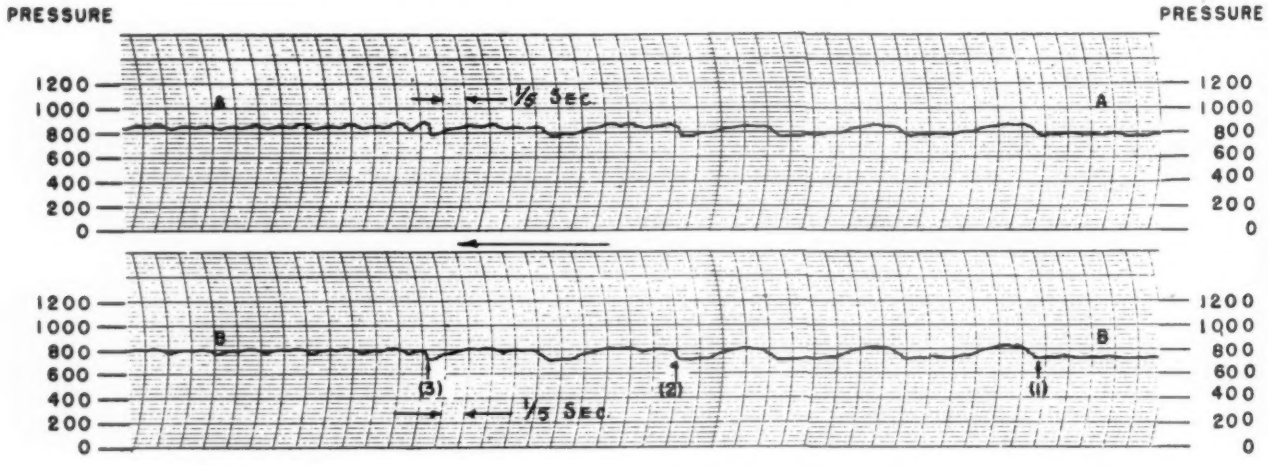
(2) ALL THREE VALVE LIFTERS ON FLUID END OPENING SIMULTANEOUSLY.

FIG. 8. Pressure surge created by opening of reciprocating pump valve lifters.

the pump. This will prevent chattering of the valve.

The manual rest feature is a design point of interest. It is obvious that automatic resetting of the valves could cause cycling of the control system. By having each valve manually reset, the operating personnel are required to be present when the load is to be placed back on the pump. With each valve closed individually, it is possible to put the load on gradually, one-sixth of total load per step in the case of a triplex pump.

Control Instruments. The control system is designed to provide stability, accuracy, ease of adjustment, and fail-safe operation. The main components



(A) PRESSURE TAP LOCATED ON DISCHARGE HEADER OF PUMPING UNIT.

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PIPELINE : FREEMAN TO LA-PLATA 129.99 MILES. EQUIVALENT 12" PIPE.

(1) VALVE LIFTER CLOSED ON FLUID END OF OUTBOARD CYLINDER.

(2) VALVE LIFTER CLOSED ON FLUID END OF CENTER CYLINDER.

(3) VALVE LIFTER CLOSED ON FLUID END INBOARD CYLINDER.

FIG. 9. Pressure surge created by closing of reciprocating pump valve lifters.

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consist of an air transmitter to convert line pressure to 3 to 15 psi air output; a "stacked" proportional controller with integral control point setting; 2 precision type pneumatic relays; air strainers, regulators, set point and operating pressure gages, all fitted into a suitable cabinet.

By using suppressed range on the air transmitter, a narrow proportional band setting in the controller and snap-action relays, control is stable and precise. The set point pressure is easily changed by adjusting the external set point regulator knob. The set point and line pressures are always visible on the indicating gages.

A view of the instrument assembly is shown in Fig. 6. Fig. 7 shows the cabinet with the service door closed and the indicating gages in plain view. The cabinet is wall-mounted near each pumping unit.

In the design of this control system, fail-safe performance was considered of paramount importance. For this reason, the combination of air and springs was used instead of electrical or hydraulic systems. In the air-spring system, loss of air pressure in the control circuit will open the pump valves. The springs are not fail-safe, but no great stress or shock is placed upon them so that failure is a remote possibility.

Evaluation of Surges

Suddenly changing the discharge rate of a pump from 50 to 100 per cent by the use of valve lifters prompts questions concerning pressure surges. In evaluating this, the manner in which a reciprocating pump works must be understood. One consideration is that suddenly opening or closing the valves on a multiple-cylinder pump cannot occur with all plungers in the same phase of their strokes because of crank angularity. Another consideration is that the discharge from each cylinder is manifolded into a common discharge line and the discharge valves can open only when the pressure within the cylinder exceeds line pressure. When the fluid pressure in a cylinder fails to exceed line pressure, there is no flow and the only reaction in the pipe line is for the pressure to diminish.

Two surge studies were made, one for long line surges coming from downstream station shutdowns and the other covering high frequency undamped impulses at the pump and discharge manifold.

Line surges were studied in the No. 2 System of the Freeman-Carrollton-La Plata section of the Service Pipe Line Company's line. This system is made up of 10 and 12-in. pipe. Freeman station has reciprocating pumps, and at Carrollton station, 77 miles dis-

IN A FREE ECONOMY

When PRICE FIXING grabs one Industry... How long can others hold out?

PRECEDENT is being set for government price control of an industry. If price fixing by FPC could be accepted as applying to natural gas only, the decision of the Supreme Court in the Phillips case would be a matter of less national and individual concern. The threat in this throttling decision to other industry, and the sovereignty of States appalls most students of the Constitutional guarantees of free enterprise.

The Natural Gas Act of 1938 has this wording in its jurisdictional section:

"The provisions of this Act . . . shall not apply . . . to the production or gathering of natural gas."

In eleven instances the Federal Power Commission itself accepted this interpretation by ruling it had no authority to fix the price of gas in the field. One such decision in 1951 was carried into the courts as the Phillips case; and in June, 1954, the Supreme Court ruled that under other wording of the Statute, the Federal Power Commission can regulate or fix the price of gas sold by a producer to a natural gas (pipeline) company in an interstate sale.

The implications of this decision were summed up by Governor Allen Shivers of Texas before the Interstate Oil Compact Commission in Chicago, like this:

"The Supreme Court's rule, in the Phillips decision, overturns all the precedents of our national experience by removing from the States the right to exercise the police powers reserved to them by the Tenth Amendment as a part of the Sovereign Bill of Rights.

"This is a drastic change, an unwanted and an unwarranted change, a change which I do not believe the people of the United States are willing to accept . . . If the power of the federal government can reach to the well heads of oil and gas fields in Texas and Oklahoma . . . it can likewise reach to the crop rows of Iowa, the dairy sheds of Minnesota, the mine faces of Illinois and wholly change the character of private enterprise as well as the character of the government of this land of ours."

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tant, the line is operated closed with centrifugal pumps relaying the stream to La Plata station, 72 miles farther downstream.

Conditions of the first test were as follows: The pumping rate from Freeman was 1950 bph with a line pressure of 768 psi. The valve lifter controls were set to reduce pumpings by one-half when the line pressure reached 785 psi, or shut off completely when the pressure reached 795 psi. This magnitude in the reduction of pumping rate could not possibly be obtained with speed control of the engine driving the pump. To simulate a power outage at Carrollton, the unit at this station was shut down and the stream bypassed to La Plata.

The Authors

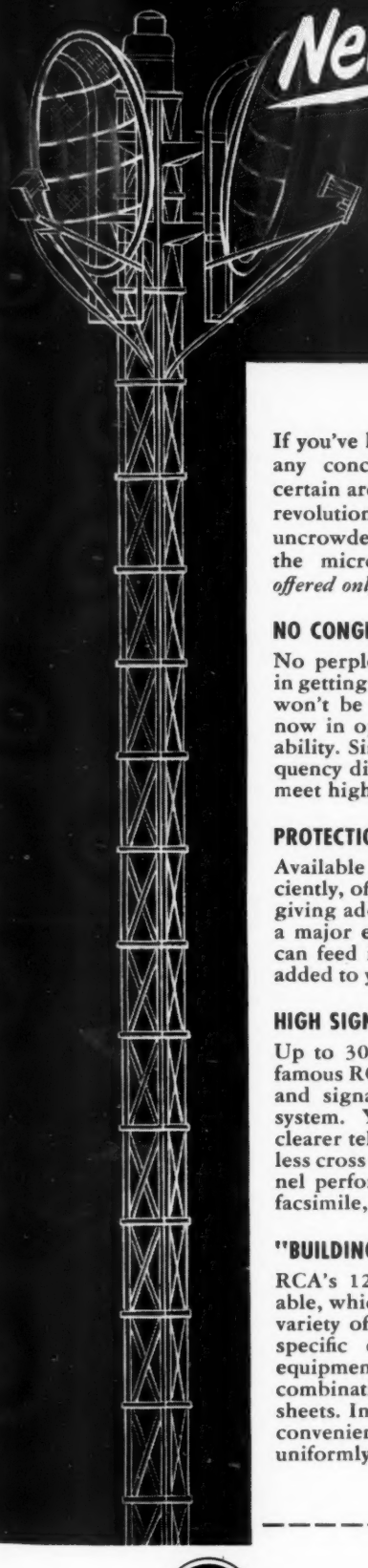
Nigh Llewellyn

Max T. Nigh is an engineer in the mechanical section of the engineering department for Service Pipe Line Company and has been involved in various phases of engineering pipe line design work for three years. He was graduated from the University of Nebraska in 1945 with a BS degree in chemical engineering. Prior to joining Service, he was process development engineer with California Research Corporation.

Thomas S. Llewellyn is assistant master mechanic in the maintenance department of Service Pipe Line Company and has been doing construction and maintenance of petroleum pumping equipment for the past 18 years in this company. He was graduated from the University of Oklahoma in 1935 with a BS degree in mechanical engineering.

The results obtained are illustrated in Fig. 1 and show that no surges occurred in the system. A pressure recording instrument on the suction line at Carrollton showed that pressure increased for nearly one minute before reaching bypass level. A slight pip at the high point of the line showing pressure increase at Carrollton was caused by the extra force upstream required to open the clapper of the bypass check valve.

A pressure recorder installed on the discharge line at Freeman station showed that nearly 2½ minutes elapsed before the pressure rise indicated that Carrollton was shut down.



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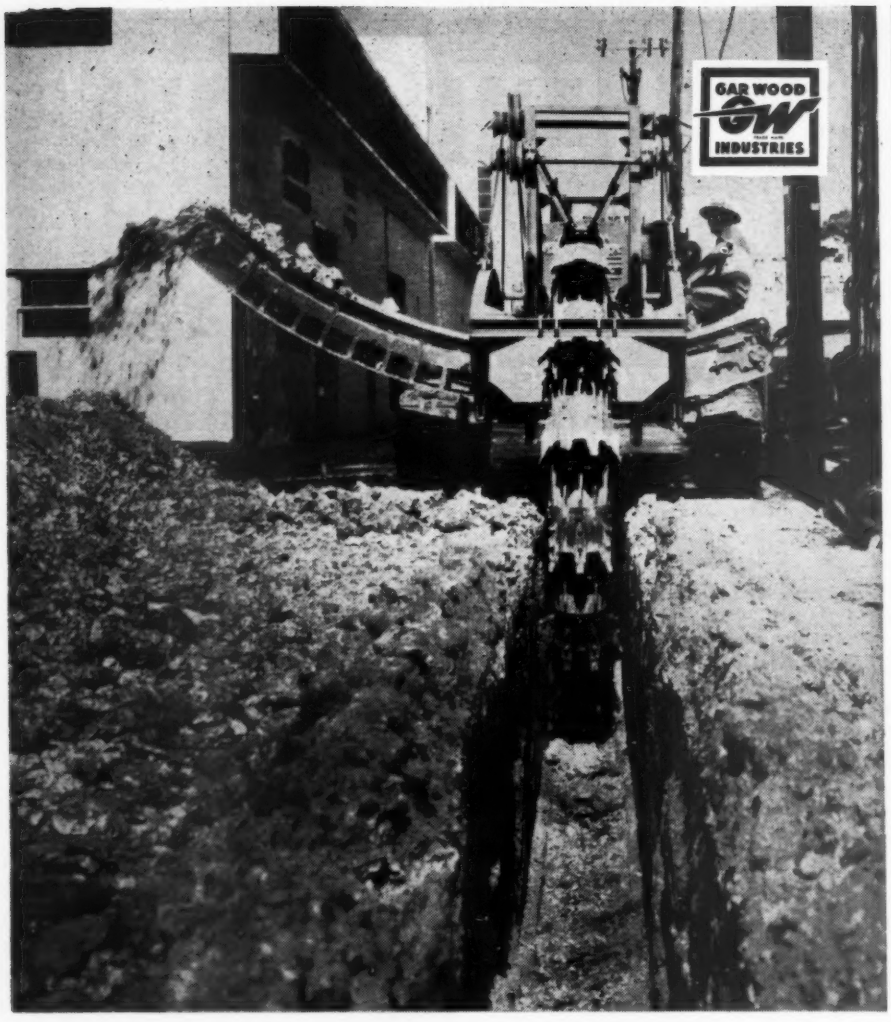

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No. 558

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The pressure at Freeman increased to 785 psi, at which point the controls cut out half the pump and slowly dropped the pressure to 710 psi. A record of the suction line pressure was made at Freeman, but no changes were observed and this record was not included in Fig. 1. The recorders used in this investigation were equipped with helical tube pressure elements.

Surge studies in a second test were made with high frequency pressure recording equipment. Strain gage fluid cells were used at the pump discharge header and at the downstream side of the discharge line check valve in the manifold. These were coupled to a dual-channel carrier amplifier, a dc amplifier on each channel, and a Brush dual-pen magnetic oscillograph recorder. The results of opening and closing the valve lifters at a pump speed of 50 rpm are shown in Fig. 8 and 9.

Records along the right side of Fig. 8 show a fine example of the theoretical impulses obtained in the discharge of a double-acting triplex pump. When half of the pump was cut out by manually lowering the set point of the control system, no surges were recorded beyond the existing operating pressure. The pressure at the pump dropped 10 per cent immediately, and continued to lower slowly due to the capacity in the line.

Fig. 9 shows the pressure impulses caused by the separate closing of three open valve lifters. The closing of each valve is distinctly shown, but no harmful surges are noted. The conditions of this test were deliberately made severe, and yet the surges experienced are insignificant in comparison to those sometimes encountered with reciprocating pumps.

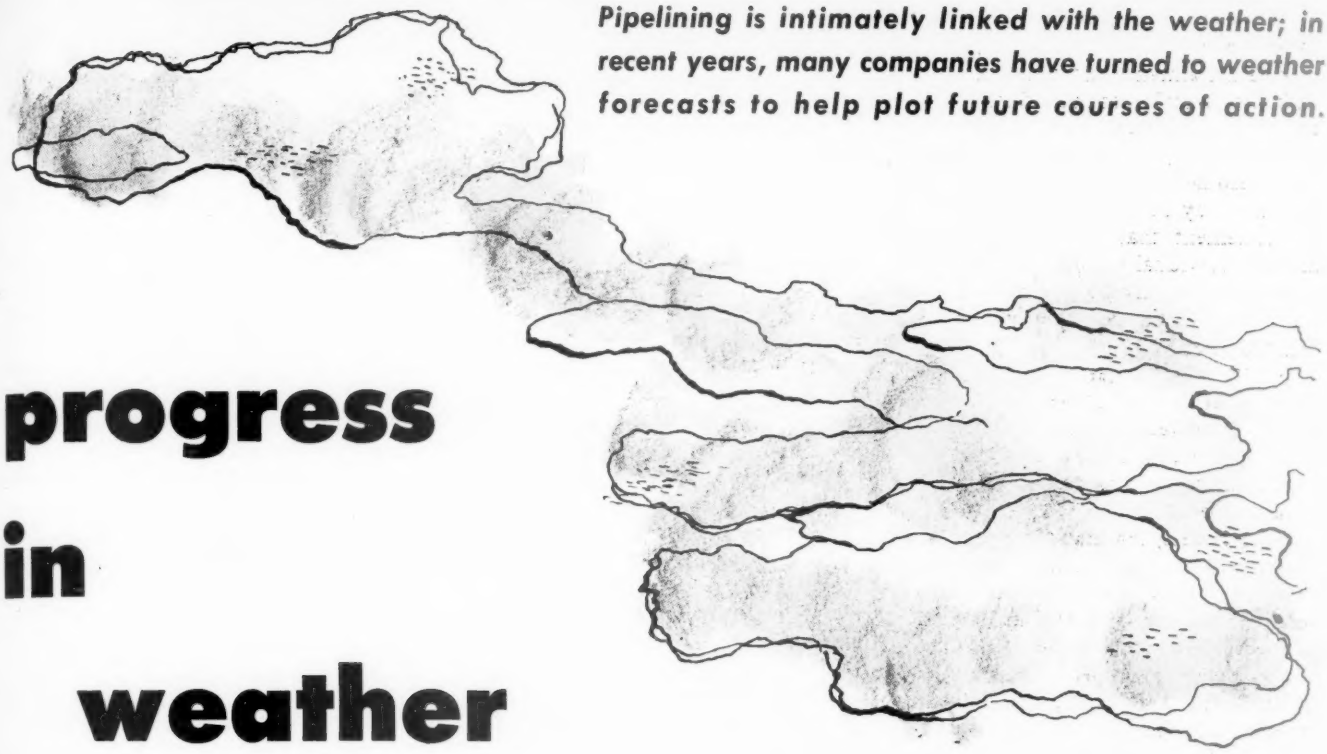
Conclusions

The control of reciprocating pump flow as outlined in this paper has definite practical application. In fact, it is being used at several pumping stations. With moderate prime mover speed control, wide flexibility in pumping rates can be obtained and the operating set point can control from either suction or discharge pressure.

Installations made to date require manual resetting of opened valves, but automatic reset is possible with the design. The manual reset feature permits checking the action of the valve at any time simply by depressing the pilot piston. This is done in a matter of seconds without interrupting normal operations.

The ease of installation, operation, and maintenance of this control system has found favor with operating personnel, whose understanding often influences the success of a control method.

* * *



Pipelining is intimately linked with the weather; in recent years, many companies have turned to weather forecasts to help plot future courses of action.

progress in weather forecasting

Francis W. Reichelderfer*

WEATHER forecasts are now published in a wide assortment of "styles, colors, and sizes." Forecasters as a rule are accommodating and optimistic, and you can obtain forecasts of sorts from one or another of them for almost any time and place. The limitations are those of *quality* — how accurate will the forecasts prove to be? On this it is "dangerous" to generalize. In fact, it is unwise to generalize on anything in weather and climate because, if you wait long enough, almost anything will happen—drought or flood, hot or cold, calm or tempest.

You may have heard it said that forecasts of temperatures that will occur on any particular day a year or more in advance are impossible. This is the view that most competent meteorologists probably would express. It is mostly true, but not always.

To get the meaning, the terms must first be defined. Do we mean temperatures a foot above the ground, or ten feet? This sometimes means the difference between freezing and not freezing. Do we mean in the sun or in the shade? It often makes a difference of 20 F, or even more. Must the forecast be right on the nose, or is a tolerance of 3 F, above or below the forecast, satisfactory for your business purposes? In some cases it is adequate; in others, not. Can you afford to take a chance on "probabilities," with the losses from a few errors averaged out by a majority of "hits"; or are you dealing with a one-shot proposition for which the accuracy of the forecast must be certain?

In the one case you might find climatological indications useful; in the other, you would require a particularized forecast giving the unusual features of specific weather elements. The points implied in these questions, and in some cases many other points, may make the difference between the possibility and the impossibility of predicting in any give case. Good illustrations are found in the possibilities of predicting temperatures months or years in advance for a particular time and place, with a maritime climate in the tropics in contrast to predicting the changeable, continental weather of some place deep in the interior of North America or Eurasia, north of latitude 40 deg.

Climatological Prospect

The distinction between a climatological prospect and a synoptic weather forecast should be kept in mind. The public often uses the word "forecast" to refer to all kinds of weather foretelling, and the result is confusion about what can and what cannot be done in forecasting with credibility. The climatological prospect is very valuable for many purposes. It can be projected as far in advance as you wish—a year or a century, provided we assume that secular changes in climate are negligible. (Recent studies show this to be another unwise generalization.)

But climatological prospects do not give the time and place of anomalies—extremes of temperature, etc., nor their duration dates. They do not foretell the time, place, and severity of a storm. Climatic data are much misused, sometimes in very unprofitable ways. There was a recent instance in which such data were about to be applied to a certain phase of defense planning in

*Chief, Weather Bureau, U. S. Department of Commerce, Washington, D. C.

a way that might have invited catastrophe.

Weather almanac users may disagree with the remark that individual storms cannot be predicted a year in advance. This question gets into technical details too tiresome for discussion here, but the case may be fairly summarized by the statement that no basis for predicting individual storms or other specific weather anomalies months or years in advance has yet been demonstrated.

A "forecast" that one or more storms will "occur" along the Atlantic seaboard between the 1st and 15th of November is about like saying that the Christmas buying rush will reach its peak in December!

Nevertheless, the many valuable applications of climatic data should not be obscured by these limitations inherent in the use of the climatological prospect. Here industry and the production engineer should profit from a careful analysis and from the advice of an expert consultant in how climatology may best be used in the business. The services of consulting meteorologists are mentioned again later.

Synoptic Forecast

The synoptic weather forecast, as distinguished from the prediction based wholly on climatological prospects, aims to foretell the particulars of weather at a given time and place—the development, path, and intensity of individual storms, the extent and severity of cold waves, etc. The prospect is based on analysis of synoptic weather patterns over the continent or the hemisphere for the period concerned, and on knowledge of how the numerous component air masses interact to produce storms and their accompanying weather. It is "tailored" to the weather of the given day rather than averaged to fit a lot of similar cases.

But the synoptic weather forecast also has its limitations—very definite ones! Although it is "tailor-made," it sometimes turns out to be a misfit. The accuracy, expressed in popular terms, runs about 90 per cent for the first 12 hr, about 85 per cent for the next 24 hr, and usually tapers off to the "no-skill" level at the end of 3, 4, or 5 days, depending on how fickle the weather is in the particular case.

This implies the second serious limitation, viz.:

The synoptic weather forecast does not give the weather day-by-day for a week or a month ahead. For these longer periods an extended forecast can give, in more general terms the daily forecast, the broad-scale variations from mean values to be expected over a period of a few days or, in still more general form, up to three or four weeks.

". . . constant efforts are being made to develop techniques for extending forecasts to two or three months ahead, but so far, there is little evidence of skill beyond the first month.

These extended forecasts or outlooks are based on modified synoptic methods, and usually employ mean weather charts. Constant efforts are being made to develop techniques for extending these to two or three months ahead, but so far there is little evidence of skill beyond the first month.

At this point a few of the "wide assortment of forecasts" mentioned in the beginning are likely to rise up to haunt us. Long-range weather forecasting is a very controversial subject —due largely to confusion of terms and need for common definitions. The preceding remarks are believed to represent the conclusions of most meteorologists at the present time.

Three Classes

If we use the term "weather forecasts" as described above, meaning synoptic weather forecasts as distinguished from predictions based solely on climatological indications, then for convenience forecasts may be grouped into the following three classes, based on their time range and some of their limitations:

1. **Daily weather forecasts** give specific information on storms, extremes of temperature, etc., reasonably accurate 36 to 48 hr ahead in 75 to 90 per cent of the cases.

2. **Extended (or weekly) weather forecasts** give, in general terms, the departures from normal for periods of days, but without day-by-day extremes. The accuracy of these forecasts drops toward the "no-skill" level near the end of their five-day scope. If they could be made more accurate for the entire period now, their scope would be extended beyond five days.

3. **Monthly or 30-day outlooks** give the very broad departures from normal for the entire period as a whole. These are still in the experimental stage; and, although they show considerable skill and have proved valuable for some purposes, their accuracy is not yet high.

Obviously, the differences between these three classes are primarily differences of degree, not fundamentals. Of course, they do not include all forms or special kinds of weather forecasts, some of which combine use of climatological data with synoptic weather information. There are aviation weather forecasts, degree-day forecasts, and shippers' forecasts published for general public use and for the business community. A still larger variety of specialized and individualized forecasts is available through meteorological consultants or private weather-forecasting offices.

All have approximately the technical limitations in time range and accuracy indicated in the foregoing. The special advantages of private consulting services in meteorology are suggested in a later paragraph.

Slow Progress

Long-range weather forecasts comparable in exactness to the predictions of eclipses and other astronomical events, or to the standard tide tables published a year or more in advance, would be of inestimable economical and social value. Why have they not been forthcoming? The *Meteorological Abstracts* of the American Meteorological Society, most comprehensive and authentic published catalog of the literature of weather science, lists more than 175 technical papers on methods of extended and long-range weather forecasting published during the last 35 years.

In addition to these selected technical papers there have been hundreds, perhaps thousands, of articles on the subject in the general press. Many of the latter are naturally untested by the forum of scientific discussion. Those in the *Meteorological Abstracts* are by authors and research workers from almost every part of the globe. And still the research continues even with increasing scope and effort.

The methods studied included every imaginable approach—extra-terrestrial causes including solar radiation, sun-spots, corona flares, etc., cycles (hundreds of them), analogues, ocean currents and their changes in temperature, variations in the composition of the upper atmosphere, and the more comprehensive phenomena of the general circulation of the atmosphere and its air masses.

Cycles in particular have had much attention, and some of them have held promise for a time; but, except for a few well-known periodicities like the diurnal and seasonal changes, they

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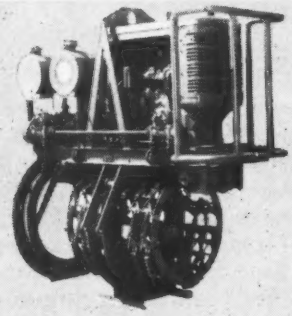

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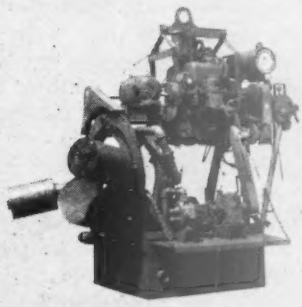

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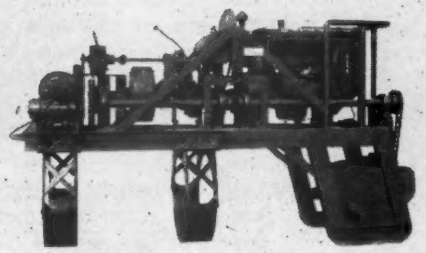

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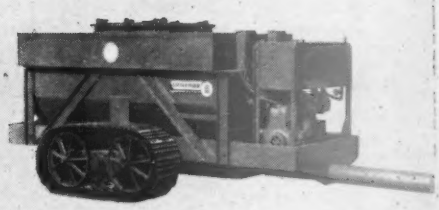

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". . . well informed use of climatological information and synoptic weather forecasts, often in combination, is doing much to reduce delays and losses due to unexpected weather."

seem to lose their prognostic value eventually. Examples are the monsoon rain forecasts for India, and the correlation of rainfall in southern California with ocean temperatures near La Jolla.

One investigator claimed to predict seasonal temperatures anomalies on the basis of trends in grain prices several decades ago! The serious side of this instance is the fact that weather correlations can be misleading because they often involve dependent variables in common. Although some of the unproved cycles are useful, it is fair to state that none found so far has been shown to give results as consistent as given by the climatological guides and weather forecasts previously described.

The Problem

Answers to the question as to why progress in this very vital subject of long-range weather forecasting has been relatively slow are to be found in the meteorological literature. In January, 1952, a paper on these problems was presented before the New York Academy of Sciences by Jerome Namias, well-known leader in research in this field. The difficulties are many and complex, and it does not appear that those who seek a simple, hidden secret to weather changes have a realistic basis for their search.

Although meteorology is a branch of physical science, and weather is the result of definite physical changes, the knowledge of atmospheric physics, the measurements of the elements involved, and mathematical science itself have not yet advanced to the stage where meteorology can be treated with the exact techniques of other physical sciences. The variables are still too numerous, and some of them too indeterminate. To see the problem, it is sometimes better to compare present-day meterology with the less exact social sciences; e.g., economics and the behavior of the stock market.

Many of the factors that determine market fluctuations are known and can be measured. Others are known but cannot be measured. Still others are unknown. Predictions of market trends are made in part objectively, in part empirically; and, like weather forecasts, they are not always accurate. The analogy is not quite sound, but it is helpful in gaining an impression of the complexities involved.

One Solution

How can the petroleum industry, and industry in general, best utilize present weather-forecasting facilities to foresee and prepare for significant changes in temperature and other weather conditions which affect operations and sales?

Naturally, the answers are different in different industries and under different operating conditions. There are, of course, differences in requirements among individual companies in the same industry. Well-informed use of climatological information and synoptic weather forecasts, often in combination, is doing much to reduce delays and losses due to unexpected extremes of weather. Probably in most industries it is necessary to have a continuing analysis of weather factors in relation to operations, and for this purpose a good consultant in meteorology is usually required.

The number of meteorological consultants in private practice is increasing, and many of them are specializing in one particular field of applied meteorology or another. As in other professional and engineering fields, the best results are usually to be obtained through the services of experienced and competent experts in the problems at hand. The American Meteorogical Society, the largest organization of meteorologists in the world, keeps a directory of consulting meteorologists and firms engaged in regular practice.

The published forecasts of the U. S. Weather Bureau are, of course, available to anyone who desires them, but these public services cannot take the place of company consultants in large industries in which meteorological factors are important.

With particular reference to forecasts of degree-days, there have been many good papers on this general subject showing the practical capabilities of weather-forecasting techniques at the present time. George P. O'Donnell, of Philadelphia, presented an interesting paper on one aspect of the subject in January this year, entitled "Marketing Heating Oil by Probabilities." Among others, H. C. S. Thom of the U. S. Weather Bureau has published articles on degree-day predictions.

Prospects for Improvement

What are the prospects for improvements in accuracy of weather forecasts? The growing importance of meteorology in modern business and social life has led to increased support for meteorological research in recent years, and the number of competent scientists and technicians in this field is now greater than ever before. Impressive and comprehensive research projects in weather problems are in progress in many countries, supported in some instances by private funds, but mostly by large government allotments or contracts.

Although revolutionary discoveries might open the way to rapid progress in weather forecasting, it seems evident from the facts mentioned in earlier paragraphs that the complex interrelationships that give rise to weather changes are not likely to yield to a sweeping general solution. It seems that the way will be long and difficult.

One of the handicaps is the lack of measurements of fundamental elements throughout the atmosphere. The meteorologist has to work with great gaps in his knowledge of the existing state of the atmosphere — gaps over the oceans that cover three-fourths of the earth, gaps in polar regions and, even more serious, gaps in soundings of the upper air where important changes in weather sometimes have their origin.

We need more general and less costly means for measuring the important elements both on the surface and aloft, preferably by automatic means, which will eliminate the cost of an impractically large number of personal observers. Developments are under way for automatic weather observing and reporting equipment, but the solution for less costly observations over the oceans is not in sight.

There are many other technical problems that need to be solved, which are deserving of greater research effort even though much is now being done. Progress in meteorology has been accelerated by major inventions or developments in other fields. For example, improvements in aircraft led to the first synoptic networks of stations for sounding the upper air for temperature pressure and humidity. There is reason to hope that the great advances in electronics and nuclear fission will also give impetus to progress in meteorology.

One of the most promising now in prospect, although here again very rapid progress is not to be expected, is the use of the electronic digital computer for prediction of weather by numerical processes.

Acknowledgment

This report was presented by Dr. Reichelderfer at the annual API meeting in Chicago, 1954. ★ ★ ★

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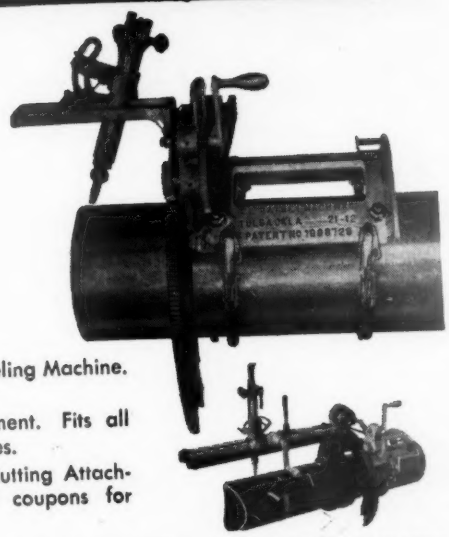

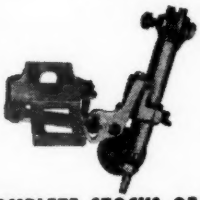

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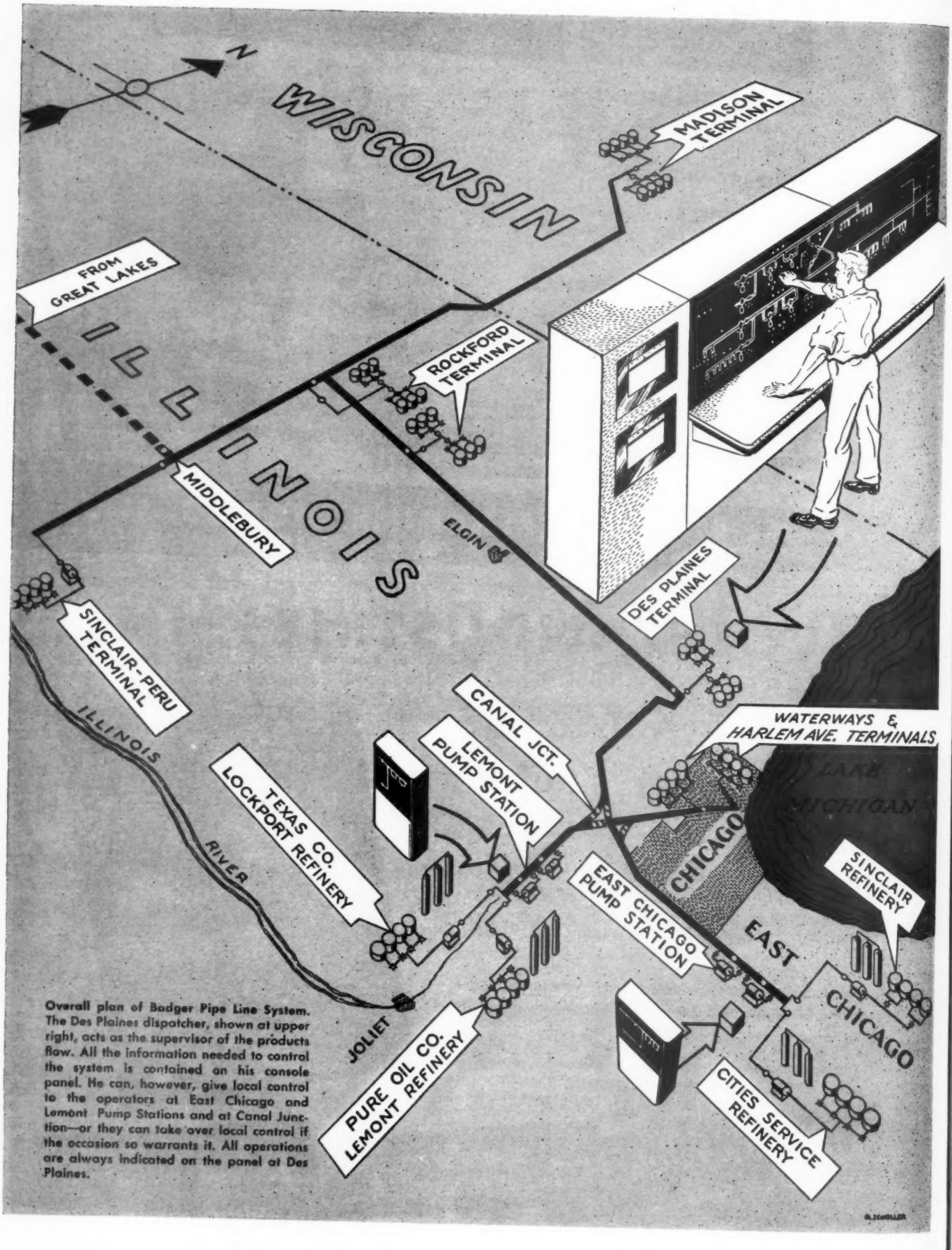

Overall plan of Badger Pipe Line System. The Des Plaines dispatcher, shown at upper right, acts as the supervisor of the products flow. All the information needed to control the system is contained on his console panel. He can, however, give local control to the operators at East Chicago and Lemont Pump Stations and at Canal Junction—or they can take over local control if the occasion so warrants it. All operations are always indicated on the panel at Des Plaines.

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The 267-mile Badger Pipe Line System between Madison, Wisconsin and Chicago, Illinois goes into full operation soon. Dispatching of the entire line is handled at the Des Plaines Terminal by means of a UNION Centralized Transport Control System which was designed specifically to meet the needs of this pipe line.

This control system furnishes the dispatcher with complete control and indication of a product throughput of 60,000 bbl. a day, at a discharge pressure of 900 psi. It provides:

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2. **COMPLETE INDICATIONS** at the control center, of movements and positions of valves and pumps and for station and unit alarms.
3. **FLOW INFORMATION** at the control center in the form of illuminated flow arrows on a graphic display panel.
4. **TELEMETERING** to indicate and record interface arrival at the Canal Junction switching center.
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Controls and indications on the Badger Pipe Line are transmitted over leased telephone circuits, but UNION Centralized Transport Control works equally well over any communications medium: telephone circuits, carrier circuits, VHF and UHF radio and microwave, as well as private wire.

The reliability of UNION Centralized Transport Control is based on its all-relay design which is the heart of the system. The relays, time-proved and job-tested in many vital installations, are engineered to give years of lasting dependable service with very little maintenance. Complete control is always assured. And the basic system is flexible and can be adapted to a variety of pipe line layouts, off-shore platforms, production platforms, and tank farms, including gathering and manifold systems.

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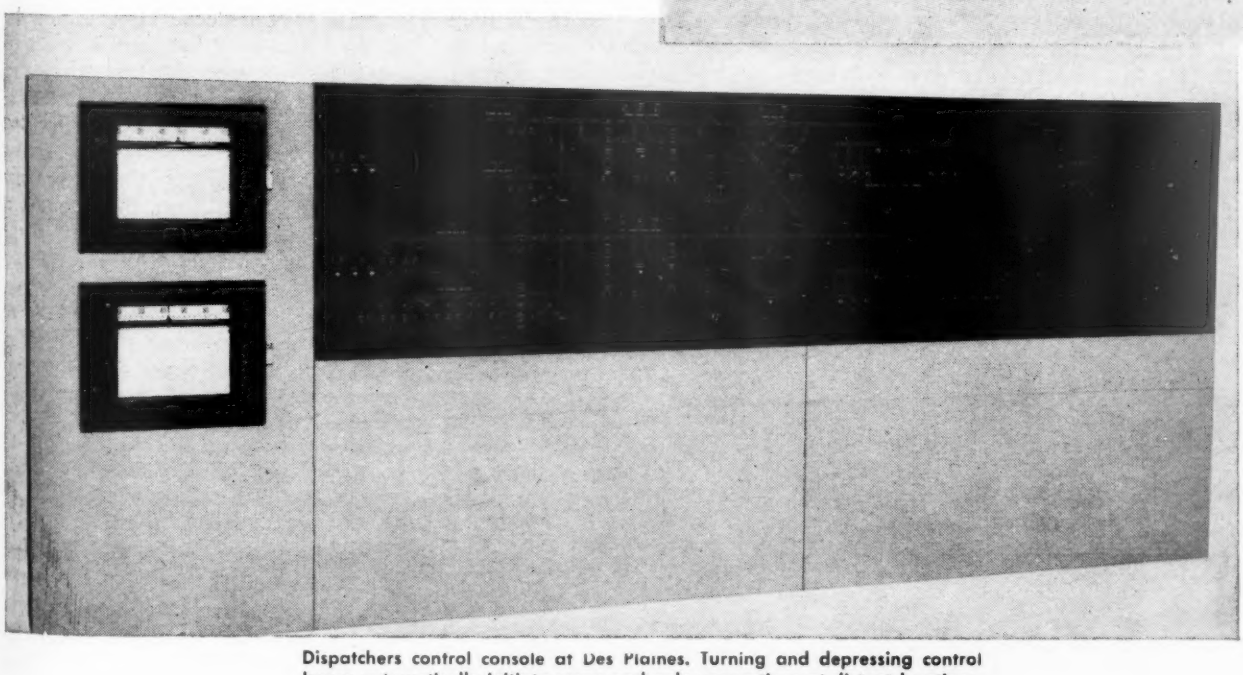


Dispatchers control console at Des Plaines. Turning and depressing control levers automatically initiate pump and valve operations at distant locations.

Old and the new. The old 22-in. partially blocked drainage ditch in an Illinois wheat field. Service cut out the old line and installed a span-type crossing to clear the ditch. Fabrication to be installed is seen lying on the bridge.

Old section of pipe is lifted from the ditch with a sideboom tractor and the dragline. Note the three flanges where the oil was pumped from the line before it was cut.

P 615.63

Small Span Crossing Is MAJOR Project

. . . Service Pipe Line's 22-in. now goes over drainage ditch in Illinois farm country

Carl Huss

INSIGNIFICANT-appearing pipe line jobs often call for special skill and planning, and cost an amount that certainly is not an insignificant sum of money. An example, for instance, is Service Pipe Line Company's recent project in central Illinois.

Central Illinois, a rich agricultural region, lies flat like a tabletop. Farmers keep water from standing on their flat farmlands through the use of an elaborate network of drainage tiles. Surface water seeps down to these tiles, buried below plow depth, and travels through them to open drainage ditches. The drainage ditches carry the water into the nearest creek or river.

Having pipelined through there since 1917, Service is conscious of the purpose of the ditches and is careful not to interfere with their function. Therefore, when the company discovered its 22-in. line wasn't buried deep enough and was interfering with the flow of a drainage ditch near Wenona, it went into action.

J. W. McFarland, superintendent of the east district, which includes that section of line, directed the project. He and his staff had a choice of either burying the line deeper or spanning the ditch. Either way they would have to cut the 22-in. line, something the company had never done before. After studying the situation, the men decided it would be less expensive and easier to install a span crossing. For one reason, they would not have to dig a deeper ditch and then face the problem of keeping water out of it as they worked.

Briefly, here is what they would have to do: Strip out several hundred feet of the 22-in. on both sides of the drainage ditch, tap the 22-in. in order to transfer the crude oil from it into a parallel 10-in., cut the 22-in., and weld in the span.

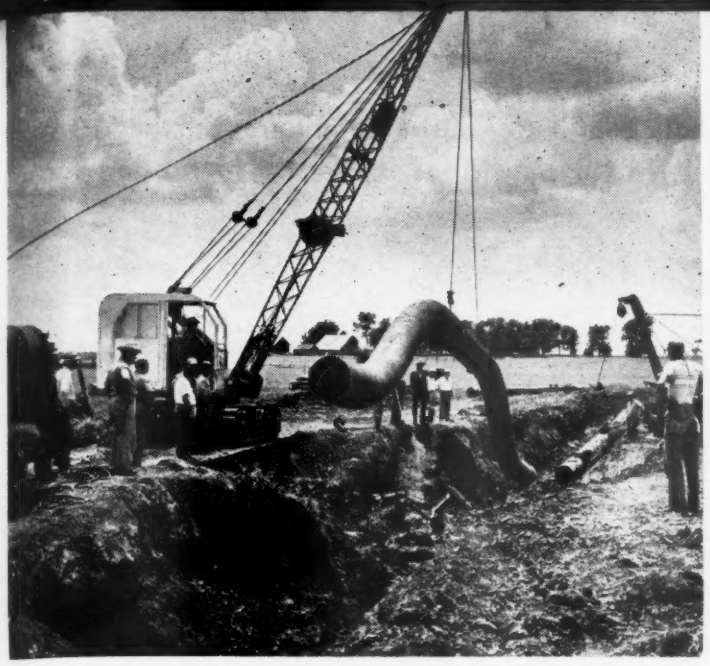
Jim Gates, engineer in the district headquarters at Joliet, drew up specifications for the job and Bob Gaston, engineer in the division headquarters at Galesburg, surveyed the site.

An East Chicago shop made the offset bends in a new section of 22-in.

Pipe saw driven by an air compressor was used to cut the 22-inch line. Line was drained of 7500 bbl of oil before the cutting.

EXCLUSIVE

XUM



Lowering the 62-ft fabrication into place with a dragline. Close timing shut down the 22-in. a minimum length of time. Project was the first time Service's 22-in. line had ever been cut.

Coupling was used to make the final east end tie-in and the west end was welded. Old section of pipe, which can be seen in the foreground, was later removed.

seamless pipe, then shipped it to Service's shop at LaRose. There division welders Milton Danielson and Henry Price welded the section into a fabrication 62 ft long.

Men from the LaRose connection crew stripped out the 22-in. with a dragline, in the meantime. Next, they tapped the 22-in. and the parallel 10-in. with a Hillco tapping machine. They made one 6-in. tap and two 4-in. taps in each line. They then tied the 6-in. to two pick-up units connected in parallel, and the two 4-in. lines to units connected in series. This arrangement gave better suction on the lines.

They vented the line with one-inch vent plugs installed at eight locations at the highest elevations on each side of the taps.

Timing of the oil transfer was extremely important. The same type crude had to be moving through both lines to avoid intermingling of different types. Oil dispatchers gave the men the go-ahead at noon one day as the tail of a batch passed the block gate 5 miles east of the work site. Laura station, the first station to the west, immediately stopped pumping through the 22-in. and the men closed the nearest gates on either side of the work site. Then they began the transfer of the trapped oil from the 22-in. into the 10-in.

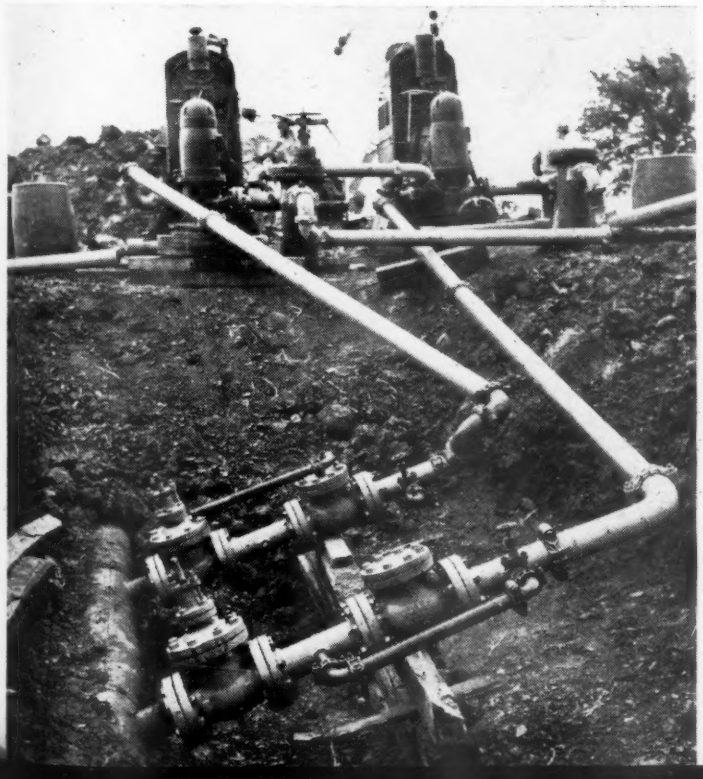
Crew members worked in shifts through the night transferring the oil. Long before work time the following morning, they had cleared the 22-in. of about 7500 bbl of oil and had it ready for cutting.

The men used a pipe saw driven by an air compressor to cut the line and lifted the old section from the ditch with a sideboom cat and a dragline.

They welded the new span-type crossing into place on the west end and used a weld-plus-end coupling to make the final tie-in.

Hurrying against the clock, the men finished the job 8 hours sooner than estimated. They had oil again moving through the vitally-needed 22-in. before dark that same day. * * *

Hookup of two of the units used to pump the 22-in. line dry before it was cut. Oil was pumped into a parallel 10-in.



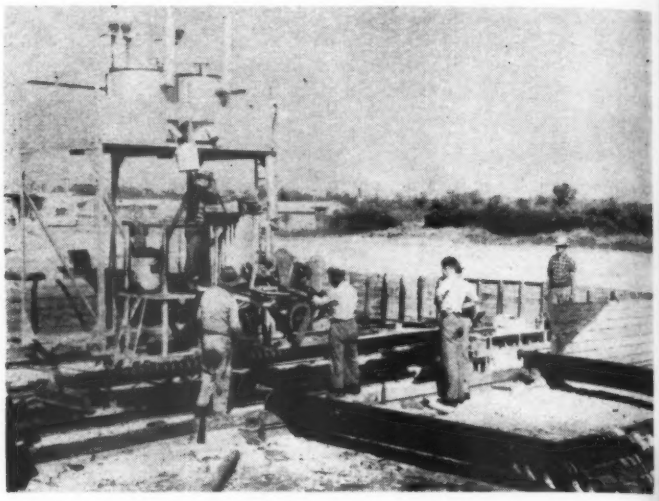
Tapping machine was used to make the three taps in the 22-in. and the parallel 10-in.

EXCLUSIVE **Dual lines to handle both heavy oils and light products laid between Fremantle and Kwinana; single trench for both lines necessary in rugged terrain**

TWIN *Product Lines*

Laid in Western Australia

In difficult areas, lines were laid in a single trench



Stationary pipe-wrapping machine used for the two products lines

Typical Australian bush country through which the Kwinana Refinery-Fremantle pipe lines were laid

A 60,000 bbl per day capacity refinery at Kwinana, Western Australia, built by Australasian Petroleum Refinery, Ltd., Australian associate of Anglo-Iranian Oil Company, has been connected with the nearby port of Fremantle by two high-pressure products lines. Work on the laying of the lines was completed late this year, and products from the refinery should be flowing through the pipe lines early in 1955.

One line, a 12-in., 15 miles long, will carry fuel oil to ships' bunkering installations on Fremantle harbor, the busiest oil bunkering port in Australia.

The other, a 17- mile, 6-in. line, will cross the Swan River and terminate at a distribution depot. Products will be pumped through this line for distribution throughout Western Australia.

The 12-in. line with two duplex-double acting ram pumps, steam driven, has been designed to handle approximately 8000 bbl daily of heavy oils. Heat lost to the ground from the lighter products, which are to be pumped hot, will be used to reduce the heat loss of the heavier oils that follow. The products line, which will use motor driven centrifugal pumps, is designed to transfer about 550,000 tons a year of products.

The 2 lines are laid side by side, with a cover of 4 to 12 ft of earth and rock. Their route generally follows that of a proposed trunk highway on which construction will begin next year.

Where space is limited both lines are being laid in a common trench, but where the right-of-way and the subsoil permitted excavation by ditcher, the lines are laid in individual trenches. Some of the trenching proved difficult, with one ¾-mile section having to be cut 12 ft deep through solid limestone.

The line was built by experienced pipeliners from many parts of the world, including 3 Americans with a total of 68 years of world-wide pipe line experience between them. They said that some of the trenching for the Kwinana-Fremantle pipe line is as tough as any in the world.

The ingenuity of these pipe-layers was tested severely at times at Kwinana. One of the problems was the need to construct a bending machine. No machine was available, but one was designed and built with a rugged frame of large diameter pipe, and a cargo winch fitted with pipe grips to bend the pipe to the desired angle without distortion or wrinkling.

Pipe used for the 2 lines was seamless, the 6-in. fabricated in Australia and the 12-in. made in Britain. Protection given the pipe included an enamel coat, a glass fiber wrap, and an asphalt-impregnated felt wrap. All welds were checked by X-ray.

Testing included both air and hydrostatic at pressures considerably higher than operating pressures.

XUM

THERE'S AN INSLEY WORKING NEAR YOU

Pipe Line Dependability

Pipe line contracting is acknowledged as one of the toughest jobs in the construction industry. Operating 24 hours a day through hilly and swampy terrain while meeting seemingly impossible time schedules at the same time, has firmly established Insley as a standard for comparison.

If your job requires this kind of pipe line dependability, let an Insley distributor show you "an Insley at work."

The Insley Manufacturing Corporation of Indianapolis has been manufacturing construction equipment since 1907. The Insley Line includes excavators and cranes, 5 to 30 ton capacity—rubber or crawler mounted.

microwave:

Seven Years Later

Dean Hale*

Since 1949, pipe line microwave systems have grown at a record pace: Over 15,000 miles in operation; future unlimited

ONE OF THE MOST REMARKABLE DEVELOPMENTS in the history of the petroleum and natural gas industry has been the rapid growth of microwave usage for communications purposes in the pipe line industry. Within a short period of seven years, the use of microwave radio has advanced from nil to a truly tremendous network of private communications facilities touching nearly every part of the nation.

A survey conducted by *The Petroleum Engineer* reveals that as of early 1955, there were approximately 15,505 system miles of microwave in operation, with another 184 miles under construction, approximately 1110 miles in the bidding stages, and an estimated 3000 miles planned or being considered. These systems include 584 stations in operation, 11 under construction, approximately 51 in the bidding stages, and an estimated 100 stations planned or being considered. The survey covers all known systems in operation, those under construction, and information available on proposed systems.

Results of the survey also revealed a number of interesting statistics. Of the 37 systems in operation, 17 are operated by natural gas transmission companies, the balance by crude and products pipe lines. Of seven systems under construction, three are for gas pipe line companies.

Nineteen of the operating systems use the 6700-mc frequency, 14 are in the 2000-mc band, and 4 use 960-mc. Under construction are three 6700-mc systems, one 2000-mc system and three 960-mc systems. There are only two 72-76 mc systems in operation in the Petroleum Radio Service, one a leg off a 960-mc system and the other is used for offshore service, not primarily pipe line.

*Editor, Oil . . . Gas . . . Products Pipelining.

Longest system in operation is Transcontinental Gas Pipe Line Corporation's 1760-mile operation between the Rio Grande and New Jersey. It also has the most stations—62. In second place is the Michigan-Wisconsin Pipe Line system with 1540 miles and 59 stations.

Chief users of microwave today in the Petroleum Radio Service, the oil and gas pipe line companies with their 15,000 miles in operation are also the biggest industrial users, and are outranked overall only by telephone and telegraph companies.

Commercial equipment first appeared in the market in 1948, but the manufacturers were without a market for their equipment. Pipe lines, with their unique requirements for long distance communications, initially were "cool" toward the idea of using an untried method, but warmed quickly to the idea of giving microwaves a "try."

First installation was made in 1949 by Keystone Pipe Line Company, whose pioneer system extended some 70 miles from its headquarters in Philadelphia, had five stations, and was designed for six-channel operation on the 2000-mc band. At about the same time, initial work was begun on long distance systems, namely the Mid-Valley Pipe Line's 1000-mile Texas-Ohio system, the 1800-mile Transcontinental Gas Pipe Line system from the Rio Grande to New Jersey, and Texas Eastern's 1400-mile system. A number of shorter systems, ranging from 40 miles to 500 miles were also begun and most were in operation by the time the second round of 1000-mile systems were started. These latter systems include the Texas-Illinois, Trunkline, Platte Pipe Line, and Michigan-Wisconsin Pipe Line, last long-distance system to be completed.

EXCLUSIVE

Big Investment

The accumulated pipe line systems in operation and under construction represent an investment of over $18,000,000 to the companies involved. That's a terrific sum to lay out for communications facilities over a short span of seven years, but it is indicative of the faith the pipe line companies have in this new and now widely accepted form of communications. Broken down into actual cost per circuit mile, costs average initially about $100 per mile, which is economical compared to what similar wire line construction would cost in view of the terrains over which most microwave systems operate.

Microwave appeared on the communications scene at what could be called the ideal time. After World War II, most of the nation's long-distance large diameter pipe line systems came into being. Their operation posed new problems, especially in communications, which are so vitally essential to coordinating the affairs of offices, pumping or compression stations, and other activities over a widespread area.

Since the early days of pipelining, communication between all outlying points and central offices has posed problems. The answer achieved by the pipeliners was to build private communications systems, which at first were telegraph systems embracing wire lines strung across the country. These later developed into telephone systems, and, as two-way radio reached a point of high development, it too was integrated into these communications facilities. Wire lines and radio served well in these areas, as most pipe lines were relatively short in length, at the most only a few hundred miles long, and dispatching was the prime function of the systems.

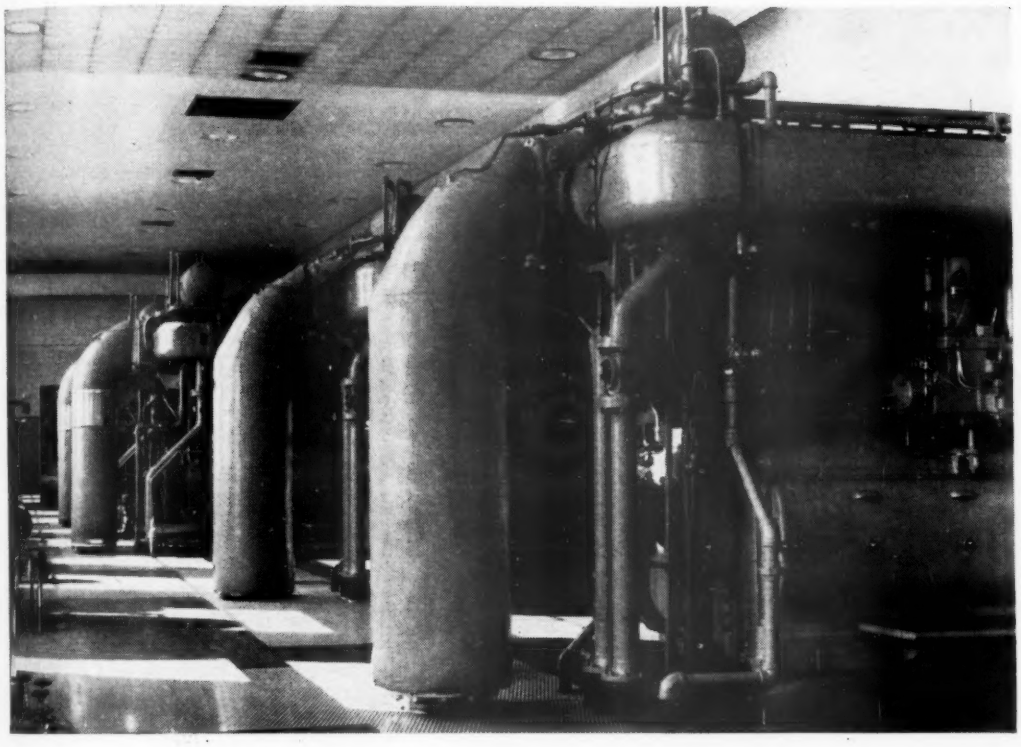
All this was changed by the long-distance pipe lines, most of which range somewhere near 1000 miles in length. On these lines are several district offices, 10 or more stations, and most likely, the main office. To tie together all these activities requires facilities for voice communication, teletype circuits, and in many cases, some form of supervisory or remote control and telemetering. Thus, better and bigger communications systems were required. Microwave was the logical answer.

A feature of microwave that has made it most attractive is the multiplexing of channels for such functions as supervisory control, telemetering, teletype, and VHF control. This "splitting" of channels into additional cir-

Another Pipe Line Company Reports

2 to 3 times more horsepower hours

. . . after installing Koppers Conformable Oil Rings



Koppers Porous Chrome* Rings. Porous chrome surface holds and distributes oil during break-in. Seats quickly. This chrome prevents grit from embedding in ring surface. Prevents cylinder wall scratching. Reduces wear 50%. Last 4 times longer than other rings.

Koppers Conformable Ring maintains constant unit pressure for positive oil control. Conforms readily to meet cylinder distortion because flexible cast iron member is pressed outward by abutment type spring which exerts uniform radial pressure around entire circumference.

*Van der Horst Process

Here's proof that Koppers Piston Rings increase operating efficiency.

Prior to using Koppers Conformable Oil Rings, a pipe line company reported average oil consumption as approximately 3500 to 4000 horsepower hours per gallon. Now they are getting 2 to 3 times that much.

In addition to this large saving in oil consumption, they find they get longer periods of satisfactory operation between overhauls.

As a result, this pipe line company has adopted Koppers Piston Rings as standard equipment on all their 12½" x 13" turbo-charged engines.

Does this suggest possible savings in your operation? Less oil consumption? Less down time, lower labor costs? Then investigate Koppers Porous Chrome* and Conformable Oil Rings. And install them next time you have a piston ring replacement job.

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PIPE LINE MICROWAVE SYSTEMS

Here's where the more than 15,000 miles and 584 stations are located as revealed by a survey by The Petroleum Engineer

Name of Company Owning and/or Operating System	Date in Service	From	To	Length Miles	No. of Stations	Frequency Band	Number of Channels
Keystone Pipe Line Compny	1949	Philadelphia, Pennsylvania	Reading, Pennsylvania	70	5	2000	6
Texas Gas Transmission Company	1950	Guthrie, Louisiana	Sharon, Louisiana	45	3	6700	5
Mid-Valley Pipe Line Company	1950	Longview, Texas	Lima, Ohio	1000	42	6700	10
Interstate Petroleum Communications, Inc. (Shell Pipe Line)	1951	Cushing, Oklahoma	Elk City, Oklahoma	160	8	6700	3
Pan American Pipe Line	1951	Snyder, Texas	Eldorado, Texas	143	9	6700	7
Panhandle Eastern Pipe Line	1952	Kansas City, Missouri	Tuscola, Illinois	400	18	6700	9
Southern Counties Gas Company	1952	Los Angeles, Califonria	Santiago Park, California	40	2	6700	5
Texas-Illinois Natural Gas Pipeline	1952	Houston, Texas	Chicago, Illinois	1004	40	6700	9
Sunray Pipe Line	1952	Purcell, Oklahoma	Ada, Oklahoma	82	5	6700	1
Great Lakes Pipe Line	1952	Humboldt, Kansas	Eldorado, Kansas	84	4	6700	4
Salt Lake Pipe Line	1952	Salt Lake City, Utah	Pasco, Washington	565	15	960	4
El Paso Natural Gas (San Juan System)	1952	Farmington, New Mexico	Topock, Arizona	450	11	6700	4
Transcontinental Gas Pipe Line Corp.	1952	Falfurrias, Texas	Newark, New Jersey	1760	62	2000	7
United Gas Pipe Line	1953	Jackson, Mississippi	Montpelia, Louisiana	126	6	2000	8
Texas Company	1953	Salem, Illinois	Kaskaskia, Illinois	20	2	960	2
Humble Pipe Line Company	1953	Houston, Texas	Kemper, Texas	450	19	6700	3
El Paso Natural Gas (Permian System)	1953	Midway, Texas	Jal, New Mexico	278	13	2000	21
Sinclair Pipe Line	1953	Cushing, Oklahoma	Independence, Kansas	190	9	6700	24
Sinclair Pipe Line	1953	Independence, Kansas	Salisbury, Missouri	260	13	6700	23
Sinclair Pipe Line	1953	East Pittsburgh, Pennsylvania	McDonald, Pennsylvania	20	2	6700	6
Plantation Pipe Line	1953	Bremen, Georgia	Athens, Tennessee	156	7	2000	13
Sun Pipe Line	1953	Hoffman, Texas	Humble, Texas	15	2	960	1
Natural Gas Pipeline Company of America	1953	Downer's Grove Illinois	Aurora, Illinois	20	2	6700	13
Natural Gas Storage Company of Illinois	1953	Herscher, Illinois	Cabery, Illinois	15	2	6700	2
Richfield Oil Corporation	1953	Los Angeles, California	Sulphur Mtn., California	60	3	6700	2
Colorado Interstate Gas Company	1954	Colorado Springs, Colorado	Keyes, Oklahoma	281	7	2000	3
Trunkline Gas Company	1954	Houston, Texas	Tuscola, Illinois	1000	32	2000	8
Platte Pipe Line	1954	Casper, Wyoming	Wood River, Illinois	1007	44	6700	9
Texas Eastern Transmission Corporation	1954	Shreveport, Louisiana	Linden, New Jersey	1400	57	200	8
Oklahoma Natural Gas	1954	Muskogee, Oklahoma	Chickasha, Oklahoma	220	11	2000	15
Wilcox Trend Gathering System	1954	Cuero, Texas	Mineral, Texas	62	4	6700	5
Keystone-Sinclair	1954	Philadelphia, Pennsylvania	Pittsburgh, Pennsylvania	460	23	2000	9
Michigan-Wisconsin Pipe Line Co.	1954	Hawsford, Texas	Detroit, Michigan	1540	59	2000	6
El Paso Natural Gas	1954	El Paso, Texas	Farmington, New Mexico	478	12	2000	4
Standard Oil of Indiana (Products Pipe Lines)	1954	Moorhead, Minnesota	Mandan, North Dakota	200	8	2000	4
Sinclair Pipe Line	1954	Salisbury, Missouri	East Chicago, Indiana	475	21	2000	24
Buffalo Pipe Line	1954	Caledonia, New York	Marrowlock Hill, New York	19	2	960	1
Tennessee Gas Transmission Company	U.C.	Kinder, Louisiana	Oakdale, Louisiana	23	2	6700	2
Industrial Gas & Supply Corporation	U.C.	Houston, Texas	Alco Mag, Texas	20	2	6700	10
New York State Natural Gas	U.C.	Syracuse, New York	Utica, New York	60	3	6700	2
Sun Pipe Line Company	U.C.	Sour Lake, Texas	Saratoga, Texas	13	2	960	1
Sun Pipe Line Company	U.C.	Barbers Hill, Texas	Liberty, Texas	18	2	960	2
General Petroleum Corporation	U.C.	Santa Fe Springs, California	Brea, California	15	2	960	1
Union Oil Company	U.C.	Torrey Hill, California	Mulholland, California	35	3	2000	4

cuits enhances further the economic aspects of microwave usage.

A recent study made by the API Central Committee on Radio Facilities reported that, in 24 systems surveyed, there were 48,025 miles of circuit in use for station-to-station voice communication; 10,119 miles used for VHF radio relay or control; 4038 miles used for teletype communication; 8923 miles used for remote control; and 21,302 miles of circuits used for telemetry. All of this on a total system mileage of 10,969 in actual use, representing a total potential equivalent voice channel mileage of 189,176 miles of which 59,722 equivalent miles are now in use.

As greater utilization is made of available channels, say many microwave people, the greater the economic advantages will be to the user. Channel usage on present systems ranges from one to 24. Some systems now planned are designed for up to 48 channels and manufacturers in some cases say they have available systems with as many as 96 channels.

Costs: The Big Question

What does a microwave system cost? What are some of the advantages and disadvantages? When the first microwave systems were offered, sales engineers were quick to give out information that it was very economical to construct, as low as $600 per mile in some cases, compared to $1000 per mile and over for simple wire line.

Additionally, they promised as high as 30 channels to meet expanding needs, said that it would be extremely reliable, simple to maintain, and economical to operate. Interruption due to weather—such as ice and storms—would be non-existent.

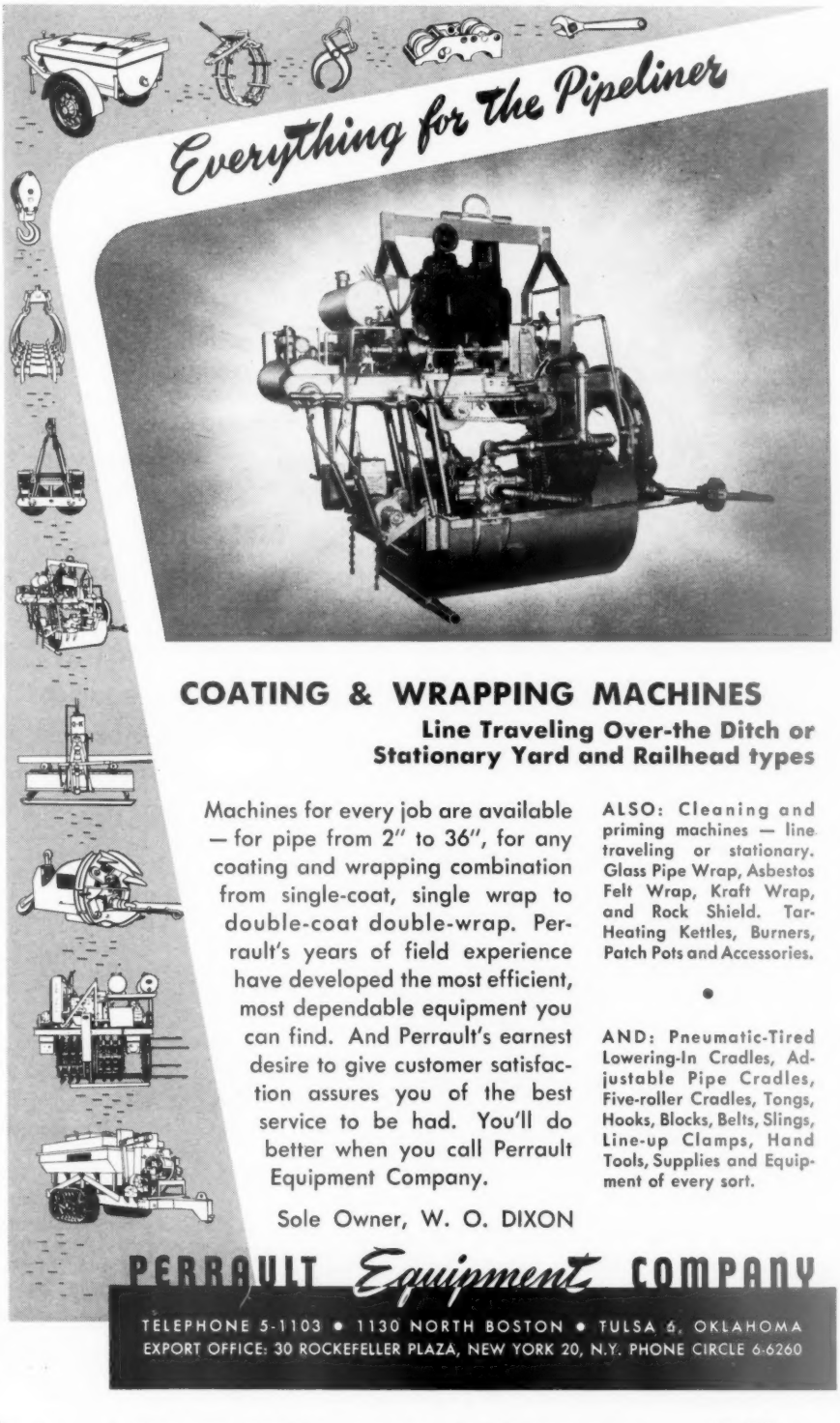
All was not so rosy, however. Costs of constructing towers, buildings, access roads in remote points, and power lines to out-of-the-way stations cast shadows over the early optimistic estimates. Supply and coordination problems arose in the case of stations in isolated locations. Technicians were hard to find, standby equipment had to be installed as protection against tube or equipment failures. Emergency power supplies had to be developed in case of commercial power failure, alarm circuits for equipment and tower lighting had to be installed, and training for maintenance personnel and development of maintenance routines was mandatory. All of these things add to the "initial" costs of equipment.

In a survey of late 1953, E. B. Dunn of Atlantic Refining Company arrived at some very interesting figures. Costs per mile estimates from 13 companies ranged from $600 to $1750, with the average about $1170 per mile. This average estimate serves fairly well, but would be low for systems in rough terrain, and a bit high for short systems or those where the going is "easy."

The foregoing estimates were for 1000-mile systems of eight channels. Thus the average initial cost per circuit mile, using a rounded figure of $1200 per mile and 8 channels, is approximately $150. For the service provided, this is quite inexpensive. No other form of communication is as economical.

Maintenance costs must also be considered. Here, Dunn found in his survey, the average yearly figure per mile for maintenance and operating expense was approximately $105 per year. This is based on an average of 5.5 stations and 124 system miles per technician for maintenance. To this cost must be added approximately $60 per year depreciation, spreading the initial $1200 over a 20-year life expectancy for the system.

Thus an average yearly cost can be estimated at about $165 per system mile, or $20.63 per channel mile, based on 8 channels. If the number of channels were doubled, or tripled, it is easy to see that costs could be brought down to a very low figure.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Reliability

One of the unfortunate happenings in the short life of microwave has been that its usage has grown so fast, and that so much has been expected of it. Lack of proper field experience, rapid changes in equipment, assembly, and design, plus the urgent needs for the equipment before it could be completely tested caused many early headaches and failures—failures that contributed to disillusionment on the part of management when faced by protests from dispatchers and other operating people.

Many of the early systems were delayed beyond the originally scheduled completion dates because of a multitude of little problems that continually occurred, and which could be traced to the lack of experience in making the installations. Despite rigid design standards, there were still "kinks" to be ironed out in equipment, and in some cases, too much was expected as more and more functions were given the equipment to perform without adequate knowledge of what might happen.

Today, with seven years' experience under their belts, the manufacturers are able to give accurate estimates on costs, predict precisely what equipment can and cannot do, and set timetables for installation that can be followed.

Reliability of microwave systems, as with any man-machine function, is a matter of experience with equipment plus good design and materials. Reliability with microwave is generally considered a function of the system outage time—those periods when the system is not in operation. Cessation of service is generally due to tube or power supply failure. Other problems contributing to outages are atmospheric fades, standby power equipment failure, cross-talk, and pulse degrading. Recent advances in component parts design has given the microwave owner assurance that specific parts will last a specified time, and this knowledge, plus a well-planned maintenance and replacement program, can materially reduce outages. (In the May issue of *The Petroleum Engineer*, a comprehensive article on Microwave Reliability will discuss this subject in full.)

At present, station outage times range from 0.2 per cent down to 0.02 per cent. Most systems operate between 0.1 and 0.05 per cent.

Looking Ahead

Of the 37 systems in operation today, only seven are 1000 miles or over in length. There are 13 systems less than 100 miles in length, and of the remaining 17, all but one are less than 500 miles long. The seven systems currently under construction are all less than 100 miles in length and five are single hops.

What trends seem to be shaping up for the future of microwave? Microwave is being considered for many widely varying types of jobs, as evidenced by the variety of systems operating, under construction, or planned. There are still many pipe lines without microwave, among them several long lines that conceivably will make the change from private wire systems or leased lines when it appears economically feasible to do so. Quite a few companies have shown more than usual interest in "joint ventures" for microwave, a technique that has received favorable attention in the construction, operation, and ownership of pipe lines themselves.

For some companies, individual private systems are out of the question; jointly-owned and shared microwave facilities, however, would not only be advisable but preferred. Inherent advantages would be reduced costs and use of many-channel equipment to provide adequate service.

Each year the annual expenditures for microwave have increased, and each year has seen the entry of several firms as manufacturers, suppliers, or fabricators of equipment and services.

* * *

LASTING ECONOMY

"DO-NUT" Wm SEAL CASING BUSHING

EASY INSTALLATION:
TAPERED O. D. OF DO-NUT IS DRIVEN INTO CASING END

SIZES: 6" PIPE AND SMALLER

STANDARD FOR DISTRIBUTION AND GATHERING LINES . . .

The DO-NUT Bushing, a solid, massive ring of synthetic rubber, slides easily over carrier pipe; THEN as tapered o. d. is driven into casing end, the flexible synthetic rubber compresses against pipe and casing forming a WATER TIGHT SEAL.

- A MINUTE TO INSTALL
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- NO METAL INVOLVED
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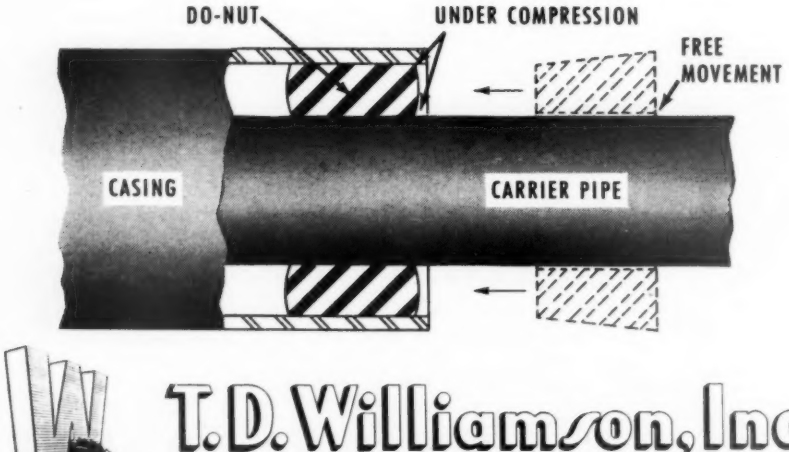
- POSITIVE INSULATION



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operating ideas

PIPE LINE

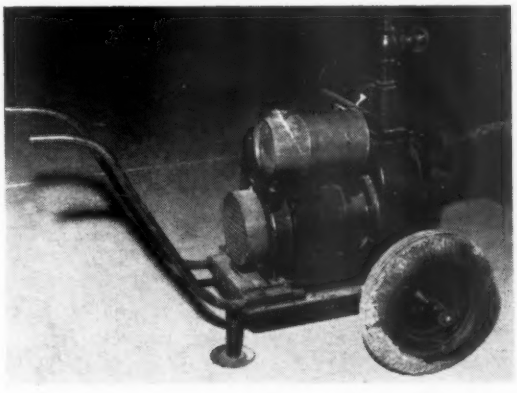
OPERATION
MAINTENANCE
CONSTRUCTION

Swamper's Helper

Any swamper who has held a welder's umbrella will appreciate this clever gadget—an umbrella holder. Instead of tediously holding the umbrella, the swamper merely sinks this holder in the ground with his foot and it does the rest.

The holder is made from a few pieces of scrap. The barrel into which the umbrella fits is made of pipe just large enough to accommodate its handle. To the bottom of this section of pipe is welded a short section of steel bar sharpened to a fine point, for penetrating hard ground. The protrudence on the side is made from two pieces of angle iron and is used in pushing the holder into hard ground.

Pump Cart



A work crew, tired of wrestling with the portable pump that is part of any line crew's equipment, dreamed up this handy cart. It can be wheeled to a pumping site by one man without much effort, whereas formerly several men had to lift and wrestle the unit to the site.

The cart is made of pick-me-up pieces of scrap. The framework on which the pump rests was made with short sections of angle iron welded into a rectangle. Bolts were welded to this framework to hold the pump, and allow it to be removed when desired. The axle that carries the two wheels (picked up at a second-hand store) is a half-inch steel bar welded to the framework. The skid is a short section of 1-in. pipe, and the handles are fashioned from ¾-in. steel bar. Note that there is a screw for adjusting their position.

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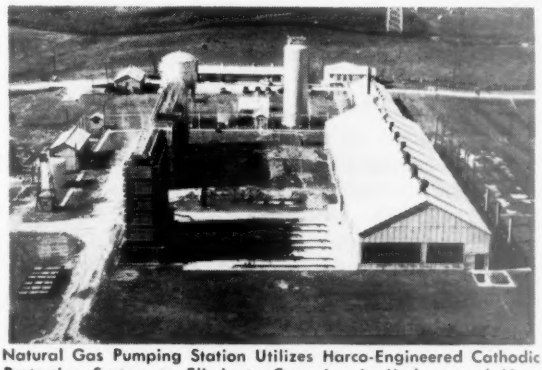

Natural Gas Pumping Station Utilizes Harco-Engineered Cathodic Protective System to Eliminate Corrosion in Underground Lines

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Pipe Line Projects

Railroad Company to Enter Pipe Line Field

Southern Pacific Railroad Company is going into the pipe line business for the transportation of refined petroleum products. Plans call for formation of a new company, to be known as Southern Pacific Pipe Lines, Inc.

Intention is to construct pipe lines from the Los Angeles, California, refinery area to Phoenix and Tucson, Arizona, and from the El Paso, Texas, refineries to Tucson and Phoenix. Total investment in line, stations and terminal facilities is estimated at $30,000,000. Products to be handled will consist of regular, premium, and aviation gasolines, diesel oil, and jet fuel.

In announcing the pipe line construction, S. P. president D. J. Russell pointed out that Southern Pacific has the great inherent advantage of its own private right-of-way, and will be in a position to serve all companies distributing petroleum products in that part of Arizona contiguous to Southern Pacific rail lines.

Movement of petroleum products between Los Angeles and Arizona points, on the one hand, and between El Paso and Arizona, on the other, has reached a point where construction of pipe lines is inevitable, the Southern Pacific president declared. There are presently no refineries in Arizona, this area being supplied from refineries in the Los Angeles basin and at El Paso.

The proposed pipe line will generally follow the railroad right of way from Watson, Los Angeles to Phoenix and Tucson, serving the important intermediate areas of Colton, the Imperial Valley and Yuma. The route to be followed between Tucson and El Paso is the shortest practical one, using the railroad right-of-way where it is economical to do so. The line will be of 16-in. from the Watson refinery area to Colton; 12-in. from Colton to Phoenix, and 8-in. to 10-in. from Phoenix to the El Paso refineries. The line is designed so that initial capacity can later be increased by 50 per cent.

The subsidiary company, Southern Pacific Pipe Lines, Inc., was incorporated in the State of Delaware in February. Its president is D. J. McGanney; vice president is E. E. Mayo, who has been chief engineer of the Southern Pacific Company since 1944.

Final route of the line has not been settled, but it will be about 800 miles long and will roughly follow the Southern Pacific rail route from Los Angeles through Colton, Indio, Yuma, Phoenix and Tucson to El Paso.

Capacity of the pipe line will depend upon pipe pressure and probably will range from about 10,000 to 20,000 bbl daily. Interstate Commerce Commission approval to build the pipe line is not required, but the ICC will have jurisdiction over traffic rates established. Engineering Management, Inc., a newly formed Delaware corporation, will handle exclusively the design and execution of this pipe line construction.

TGT Planning 731-Mile Expansion Program

Construction will begin about May 1 on a 248-mile extension of the Tennessee Gas Transmission Company's pipe line system from North Central Pennsylvania to the outskirts of New York City to serve principally the New York City-Northern New Jersey metropolitan area.

The project entails construction of of 248 miles of 24-in. from Hebron Storage Field in Pennsylvania eastward across that state, New Jersey and New York to near Greenwich, Connecticut. There it will connect with the south end of the company's New England pipe line system.

On completion of the Hebron-Greenwich line this fall, deliveries totaling 75,000,000 cu ft per day will begin to four companies in the New York City-Northern New Jersey metropolitan area.

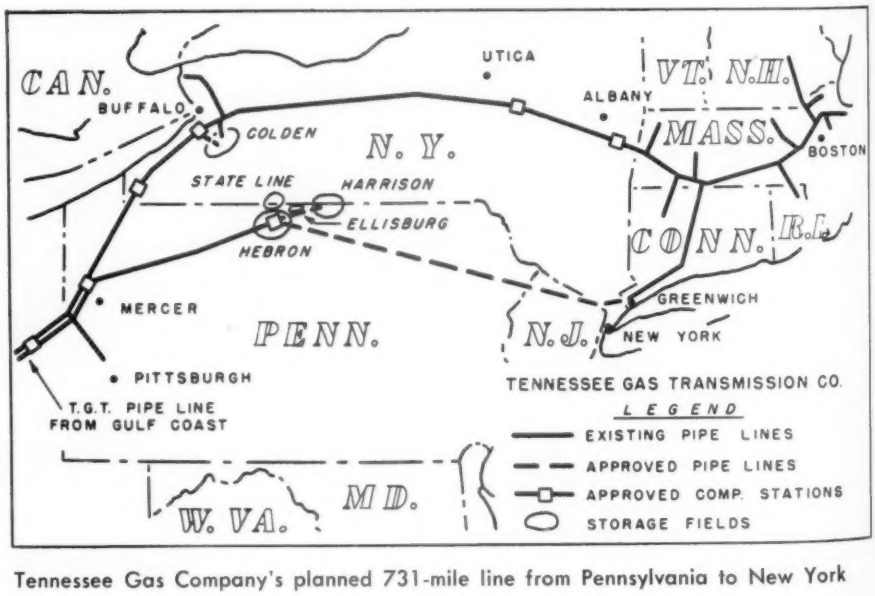
The pipe line is one of the key projects in a major company construction program for 1955 which includes laying 731 miles of large-diameter line in Pennsylvania, New Jersey, New York, Ohio, Louisiana and Texas, construction of two new compressor stations and enlargement of four existing stations.

Wilcox System Plans Facilities Expansion

Wilcox Trend Gathering System, Inc., has filed application with the FPC for authorization to construct and operate additional compression facilities, 16 miles of 16-in. pipe line, some smaller lines and a field compressor station. Estimated cost of the project is approximately $2,900,000.

The proposed facilities will increase system capacity of Wilcox to approximately 200,000,000 cu ft per day. This has become necessary to fulfill an anticipated daily delivery obligation by December 31, 1955, of amounts of gas in excess of 180,000,000 cu ft per day.

The proposed facilities include a new 2000-hp compressor station to be located in Goliad County near Charco, Texas; additional compression totaling 2200 horsepower to be added to the company's existing station near Thomaston, Texas; 16 miles of 16-in. line looping the company's mainline extending in a southwesterly direction from Provident City, Texas; some additional small diameter lines and one 75-hp field compressor station. The company also proposes to purchase two existing lateral lines that connect wells to the company's mainline.



Tennessee Gas Company's planned 731-mile line from Pennsylvania to New York

Transco Awards Contracts On 534 Miles of Loop

Contracts to lay 315 miles of 36-in. line and 219 miles of 30-in. line in eight states have been awarded by Transcontinental Gas Pipe Line Corporation to seven pipe line contractors.

Raymond H. Crowe, Transco's chief engineer, said that work would start in April and be completed this fall.

Locations, size of line and mileages are as follows:

Louisiana, 5.31 miles of 36-in. and 25.4 miles of 30-in., O. R. Burden Construction Corporation, Tulsa, Oklahoma.

Louisiana-Mississippi, 63.5 miles of 36-in., Associated Pipe Line Contractors, Inc., Houston, Texas.

Alabama, 14.45 miles of 30-in. and 53.55 miles of 36-in., Midwestern Constructors, Inc., Tulsa, Oklahoma.

Alabama-Georgia, 84.8 miles of 36-in., Houston Contracting—H. C. Price, Houston, Texas.

Georgia-South Carolina, 76.8 miles of 36-in., Western Pipe Line Constructors, Austin, Texas.

South Carolina-North Carolina, 36 miles of 30-in. and 31.4 miles of 36-in., Panama-Williams Company, Houston, Texas.

Virginia, 72.2 miles of 30-in., Williams Brothers Company, Tulsa, Oklahoma.

Virginia-Maryland, 71 miles of 30-in., Associated Pipe Line Contractors, Inc., Houston, Texas.

Magnolia Planning Loops On West Texas System

Magnolia Pipe Line Company has announced plans to add 215 miles of new 12, 14, and 16-in. pipe to its present crude oil system from West Texas to Corsicana. The new project will give Magnolia two complete lines from the Permian Basin area to Corsicana, central terminal of Magnolia's pipe line operations.

Loops will be laid at various points along the company's 335-mile pipe line span from Midland to Corsicana and will increase the capacity of this system to 162,000 bbl per day.

The company's pipe line in West Texas gathers large volumes of crude oil from the vast Permian Basin area in West Texas and eastern New Mexico. From there the crude moves through main line facilities in to Corsicana and from there oil is sent to eastern refineries or is pumped to Beaumont where Magnolia's largest refinery is located.

Coupled with the pipe line construction project are plans for enlarging pumping equipment at six of Magnolia's main line pump stations between Midland and Corsicana. This project will also necessitate a new pumping station near Groveton, Texas.

Work on the West Texas line is scheduled to begin in April. The program will be completed around October 1.

FPC Issues 34th Annual Reports, Notes "Events"

The fiscal year 1954 is described as a "memorable period" by the Federal Power Commission in its thirty-fourth annual report, covering the 12 months ended June 30, 1954.

One of the most important events of the fiscal period, the Commission indicated, was the Supreme Court's decision on June 7, 1954, in the Phillips Petroleum Company case, which brought an estimated 5000 independent producers of natural gas under FPC regulation.

In the field in natural gas, the Commission said, further expansion of the interstate network of pipe line systems was reflected throughout the fiscal year in the FPC's natural gas certificate activities. The Commission reported that it disposed of 190 applications for new and additional construction as compared with 171 in the 1953 fiscal year. These involved 9339 miles of pipe line and 276,760 hp in compressor capacity —with a total estimated cost of $631,-173,205. At the end of the fiscal year 1954, the FPC said, 83 certificate applications for facilities costing a total of about $374,017,607 were pending.

The Commission declared that regulating the rates of interstate natural gas companies continued as one of its major problems despite successful efforts to speed up the handling of filings. A total of 706 rate filings were made during the fiscal year 1954 as compared with 662 in the preceding year, with increases totaling $124,000,000 annually as against $112,000,000 in 1953. However, due to faster handling, about $155,000,000 in rate increase applications were disposed of, including actions on the backlog from the previous year.

API Products Pipe Line Conference at Chicago

Six technical papers, an all-day field trip, a panel session, and round-table discussions are among the many features being scheduled for the sixth annual Products Pipe Line Conference to be held in Chicago May 16-18.

The field trip on May 17 will include visits to the facilities of the following companies: Standard Oil Company (Indiana), Whiting, Indiana, Wolverine Pipe Line Company, East Chicago, Indiana; Shell Oil Company, Argo, Illinois; Badger Pipe Line Company, Lemont, Illinois; General American Transportation Corporation, Argo, Illinois.

The agenda for the third day calls for a panel session in the morning and the round-table discussions in the afternoon.

LPG Line Planned by Magnolia Pipe Line

Magnolia Pipe Line Company plans to convert one of its crude oil lines running from West Texas to the Beaumont area into natural gas products service. The move is part of a continuing program aimed at concentrating liquefied petroleum gases at Magnolia Petroleum Company's large underground storage reservoirs at Hull, Texas.

The present line originates at Midland and will tie into gasoline plants in the Pegasus-Midkiff areas as well as lines from other sources in West Texas. The converted pipe line is 8-in. to Corsicana, where it joins a 10-in. line that will carry the LPG products to Hull and to Magnolia's refinery at Beaumont, where new facilities will separate the stream into various products. The butanes and propane can then be moved to Hull storage in lines already available.

Work of converting the line will begin soon and is scheduled for completion by January 1, 1956.

As part of the same program, Magnolia Petroleum is now drilling an additional well in the salt dome at Hull where LPG products are stored in the artificially made cavities far below the surface of the ground. The company plans to drill more wells during 1955 as a move toward establishing a whole system of such storage cavities for various products in the Hull salt dome formation.

Movement of natural gas products to the Beaumont-Hull area is part of a long-range program that will bring the company's LPG products from West Texas to the Gulf Coast area.

Shell Pipe Line Wins Safety Council First

For the fifth time in eight years, first place in the National Safety Council competition for Class A pipe line companies has been won by Shell Pipe Line Corporation. There are 21 class A companies—firms having more than 500 employees—participating.

Statistically, Shell had a frequency rate of 1.04 disabling injuries per million manhours worked during 1954, the second lowest frequency ever achieved by any pipe line company.

South Texas Begins TGT Gas Deliveries

South Texas Oil and Gas Company has begun delivering 10,000,000 cu ft of gas daily to Tennessee Gas Transmission Company through a recently completed 22-mile gathering system following receipt of permission from the FPC. The gas is produced from South Texas' leases.

Trans-Canada Changes Plans, Will Use 34-In. on 600 Miles

As a result of recently completed engineering studies, Trans-Canada Pipe Lines has decided to use 34-in. pipe on the 600-mile Alberta border to Winnepeg section of its proposed 2250-mile system.

Original plans called for use of 36-in. pipe. The change would have no effect on the company's plans for other sections, where 24 and 30-in. pipe will be used, nor on the plan to export gas from Alberta at the rate of 540,000,000 cu ft daily.

AGA Transmission Meeting Has Full Program

New developments and advances made in natural gas production, transmission, processing and measurement will be discussed at the Natural Gas Supply, Transmission, and Storage Conference sponsored by the Operating Section of the American Gas Association, May 9-10, at the William Penn Hotel, Pittsburgh.

General sessions will be conducted both mornings, with luncheon sessions and round-table discussions in the afternoon.

George W. McKinley, Hope Natural Gas Company, chairman of the transmission committee, will preside at the general session on Monday. J. H. Collins, Sr., New Orleans Public Service Inc., vice-chairman of the operating section, will report on the section's activities. Raymond W. Todd, Pacific Lighting Gas Supply Company, will talk on gas measurement for underground storage. C. J. Hauck, Ohio Fuel Gas Company, will discuss hydraulic fracturing.

New developments in detergents for cleaning pipe lines will be reported by Clinton McClure, El Paso Natural Gas Company. Arthur Kohl and Fred Riesenfeld, Fluor Corporation, will describe advances made in conditioning natural gas for transmission. R. D. Ricketts, Fish Engineering Company, will complete the morning program.

C. W. Studt, Union Gas System, chairman of the AGA Committee on Underground Storage will be chairman at the general session on Tuesday. H. L. Fruechtenicht, Jr., Michigan Gas Storage Company, will present the informative annual statistical report on "Underground Storage of Gas in the United States," compiled by the subcommittee on statistics which he heads. A. Bruce Bowden, Mellon National Bank & Trust Company, Pittsburgh, will talk on the financial aspects of underground storage.

The importance of weather in relation to gas dispatching will be reviewed by Dr. Irving P. Krick, weather consultant from Denver. Microwave, as a medium of communication in the gas industry, will be discussed by C. E. Upson, Texas Illinois Natural Gas Pipeline Company. Clark F. Jones, National Fire Protection Association, will talk on "Disaster Control" and action taken by gas companies to continue services in emergencies. Papers on research and corrosion will be delivered by J. L. Thompson, Michigan Wisconsin Pipe Line Company, head of the pipe line research committee, and J .W. Berringer, Panhandle Eastern Pipe Line Company, vice-chairman of underground corrosion mitigation.

The luncheons will start at 12:30 and continue through the afternoon. Monday meetings will cover measurement, production, communications, compressors, and pipe lines. Tuesday afternoon meetings will be devoted to communications, storage, dispatching, and the revised Code for Pressure Piping.

E. N. Armstrong, Transcontinental Gas Pipe Line Company, will preside at the measurement meeting on Monday. W. E. Ferguson, The Ohio Fuel Gas Company, will head the group discussing natural gas production and S. A. Chadwell, Columbia Gas System Service Corporation, will serve as chairman at the luncheon session.

New RUBEROID PIPELINE SHIELD

means extra safety in extra tough areas

V.I.P.'s (Very Important Pipelines) take an extra beating in mountain cuts and river crossings from rock abrasion and penetration. The standard covering of felt and enamel is not enough to insure long, maintenance-free performance. In such areas, Ruberoid's new Pipeline Shield is the made-to-order extra protection that pipelines need.

Pipeline Shield is made of two or three-ply premium felt impregnated with bitumen. It's extra tough and durable to withstand extremes of abrasion and penetration . . . to keep lines operating without costly interruptions for repair.

Pipeline Shield is easy to apply right over the felt outer covering. Available in 5' lengths . . . in widths from 12" to 116" to fit any size pipe. One or two man crews can quickly install it with 1" metal strapping. Seals (660 per 1000') are just as simple to install.

When laying pipelines through rocky areas or underwater, give them that extra margin of safety with Ruberoid Pipeline Shield. It will mean extra years of trouble-free performance in those extra tough areas.

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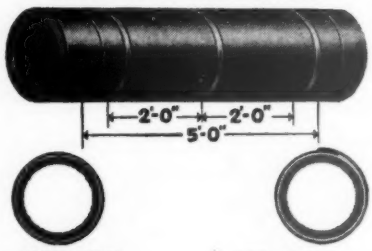

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Reserves Continue to Increase, Gains Cited

Proved recoverable natural gas reserves in the United States on December 31, 1954, reached a new high of 211.7 trillion cu ft, an increase of 263 billion cu ft over reserves of 211.4 trillion cu ft a year earlier, according to a joint report of the Committee on Reserves of the American Gas Association and the American Petroleum Institute. Extensions and revisions, and new discoveries of natural gas in 1954 thereby again exceed production, which also attained a new peak of 9.4 trillion cu ft. Production of natural gas was about 2 billion cu ft more in 1954 than in the previous year.

The AGA Committee on Natural Gas Reserves estimated that proved recoverable reserves of natural gas liquids had decreased slightly at the year-end to total 5.2 billion bbl on December 31, 1954, as compared with record reserves of 5.4 billion bbl on the comparable date in 1953. Production of natural gas liquids during 1954 totaled 301,000,000 bbl as compared with 303,000,000 bbl produced in 1953.

Crude oil reserves in December 31, 1954, totaled approximately 29.6 billion bbl, compared with 28.9 billion bbl at the end of 1953, also a new record. The total estimated liquid hydrocarbon reserves on December 31, 1954, were 34.80 billion bbl, compared with 34.38 billion bbl a year earlier.

New discoveries of natural gas reserves in 1954 totaled 5.0 trillion cu ft compared with 7.1 trillion cu ft of new reserves brought in during 1953. Extensions and revisions of previous estimates during 1954 added 4.6 trillion cu ft to the proved recoverable reserves. Such expansions and revisions totaled 13.4 trillion cu ft a year earlier. Nearly 90.9 billion cu ft of natural gas were added to estimated reserves in underground storage during 1954.

Following is a tabulation of natural gas reserves and production:

NATURAL GAS

	Dec. 31, 1954 Mcf	Dec. 31, 1953 Mcf
Reserves, natural gas	211,710,732,000	211,447,132,000
	1954	1953
Production, natural gas	9,426,509,000	9,238,540,000

(The production figures for 1954 are net after deducting the amount of gas returned to reservoirs for cycling and pressure maintenance.)

LIQUID HYDROCARBON RESERVES

(Barrels of 42 gal)

	Dec. 31, 1954	Dec. 31, 1953
Reserves		
Crude oil	29,560,746,000	28,944,828,000
Natural gas liquids	5,244,457,000*	5,437,922,000
Total liquid hydrocarbons	34,805,203,000	34,382,750,000
	1954	1953
Production		
Crude oil	2,257,119,000	2,311,856,000
Natural gas liquids	300,815,000	302,698,000
Total liquid hydrocarbons	2,557,934,000	2,614,554,000

*Decrease under 1953.

Gas Institutes Short Courses Slated for July Sessions

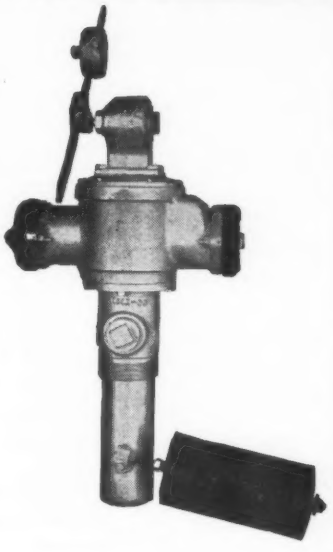
Four refresher courses in natural gas engineering will again be held this year at the Institute of Gas Technology in Chicago as July summer sessions. The courses will be developed around the fundamentals in four major areas of operation, and each course will consist of three weeks of training.

Courses offered and dates, include Production and Processing, June 13-July 1; Transmission, July 5-July 22; Distribution, July 25-August 12, and Utilization of Natural Gas as a Fuel, August 15-September 2.

OU Gas Measurement Short Course Set for April

The 1955 session of the Southwestern Gas Measurement Short Course, to be held April 19-21 on the University of Oklahoma North Campus, will mark the 30th year the annual course has been held. In that period, annual attendance has grown from 60 persons to well over 1000 yearly.

A record attendance has been forecast for this year's meeting, which will consist of one general session and 21 classroom discussion periods. Some 90 instructors from the gas industry, manufacturers, and educational institutions will aid in conducting the course.



Those endless steps to check tanks are now unnecessary. With an Enardo semi-automatic fill valve, the cocking lever mechanism is also a visual indicator of fluid movement and may be seen from the ground. The lever is easy to cock from the catwalk, just push end of weight lever down and your visual indicator is set. Lever weight up, tank filling; lever weight down, tank full and oil routed to next tank.

Optional equipment on the semi-automatic fill valve is a switch that will shut down the pumping engine, actuate a light on a central control panel, or in night operations, turn on a light at the tanks.

Find out how this process correlates with the Enardo Vapor Control system, by eliminating excessive opening of your hatches.

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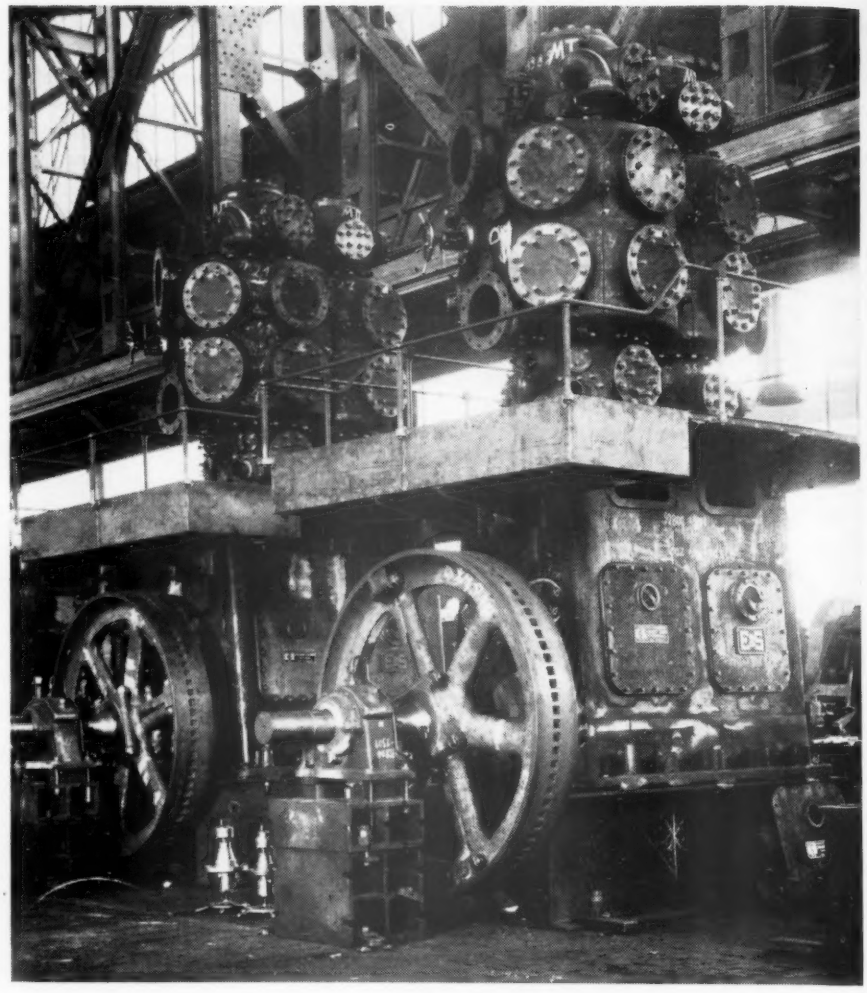


The 250-mile Lorraine-to-Paris gas pipe line was completed with the installation of the last two vertical compressors, shown above, at the midway compressor station at Point-o-Mousson

LORRAINE-PARIS Line in Service

A 250-mile gas pipe line from the mines and steel mills of the Lorraine to Paris went into service in late November, as the last 2 of 8 vertical gas compressors, supplied by the Sarrebruck firm of Ehrhardt and Sehmer, were installed in the $1,000,000 compressor station at the midway point of Pont-a-Mousson.

On June 7, 1951 the Lorraine-to-Paris pipe line, a network servicing hundreds of small provincial towns as well as some of France's most important cities, was a paper project under discussion by the state-owned gas company, Gaz de France, and nine of the chief producers of coke gas of the Lorraine coal and steel basin. The plan provided for a daily quota of 35,000,000 cu ft of gas to be delivered from these eastern steel mills and coal mines to Paris and the cities and towns on its route.

This winter, Paris will be using Lorraine gas. The project is completed except for three auxiliary lines projected to the towns of St. Mihiel, Vaucouleurs, and two Paris suburbs, Massy and Joinville. Full service is expected by January 1, 1955.

Between the approval of plans and actual start of construction, more than a year elapsed. During this time surveys were made of the pipe line route. Ten different sources of the gas in the Lorraine, including eight batteries of steel mill coke ovens in as many localities and two mine coke batteries, were united. Much difficult terrain and three of France's major rivers—the Moselle, the Meuse, and the Marne, had to be crossed by the pipe line.* The project used American materials and techniques, aiding one of France's most ambitious postwar projects to be carcied out in an amazingly short time. * *

(*See Page D-31, *The Petroleum Engineer*, March, 1954.)

WITH THE PIPE LINE CONTRACTORS

● **Engineering-Construction Company, 402 North Cheyenne, Tulsa, Oklahoma.** Has 150 miles, 6 to 10-in. gas line for *Southeast Alabama Gas District*. Two spreads: Gene Coulter, superintendent at Eufaula, Alabama, and Jim Williams, superintendent, Headland, Alabama.

● **Houston Contracting Company, 2707 Ferndale Place, Houston 6, Texas.** Has 65 miles of 12-in. products line for *Shell Pipe Line Corporation*, Baton Rouge to Norco Refinery (New Orleans), Louisiana. Job resumed and underway after delay due to right-of-way acquisition. Also has 57 miles of 20-in. gas line for *Tennessee Gas Transmission Company* between Kinder and Pecan Island, Louisiana. Also has 84.8 miles of 36-in. (with H. C. Price Company) in Alabama and Georgia for *Transcontinental Gas Pipe Line Corporation*.

● **Merritt-Chapman & Scott Corporation, 260 Madison Avenue, New York 16, New York.** Has 53 miles of 8 to 24-in. between Bombay and Butcher Island for *Bombay Port Trust*, India. Also 16 miles of 16-in. between refinery and Sydney for *Australian Oil Refining*.

● **Gragg, Canada, Ltd., 295 Kipling Ave. South, Toronto 18, Ontario.** Has two 16-in. river crossings on Red River south of Winnipeg for *Winnipeg and Central Natural Gas*. Also approximately 2 miles of 12-in. loop line for *Consumers Gas Company* in Toronto.

● **Missouri Valley Dredging, 222 William Street, Omaha 8, Nebraska.** Has take-off facilities from Harbor Pipe Line at Trenton, New Jersey, for *Sinclair Pipe Line;* 4 miles of 8-in. at Trenton for *Gulf Oil*, and river crossing at McConnellsville, Ohio, for *Tennessee Gas Transmission*, 1254 ft of 26-in.

● **Ferguson Construction Company, Eunice, New Mexico.** Has 43 miles of 5 to 8-in. crude line for *Texas-New Mexico Pipe Line Company* in Eastern New Mexico and West Texas. W. W. Shipley, superintendent, Lovington, New Mexico.

● **Anderson Bros. de Venezuela, S.A., 3200 Wheeler St., Houston, Texas.** Has approximately 27 miles 24-in. crude line in Venezuela for *Shell de Venezuela Pipe Line Company*. Earl Saulsman, superintendent.

● **Arey Construction Company, Box 1501, Pampa, Texas.** Has 100 miles 6-in. for *Shamrock Oil and Gas Company*. Amarillo to Lubbock, Texas. H. V. Gorman, superintendent.

● **Baughman Contracting Company, Box 569, R. D. #1, Cumberland, Maryland.** Has large amount various sizes for *Manufacturers Light and Heat Company, West Virginia Natural Gas, and Cumberland and Allegheny Gas Company*.

● **Brown and Root, Inc., 4100 Clinton Drive, Houston, Texas.** Has 30 miles 16-in. underwater crude line for *Shell de Venezuela Pipe Line Company*, Lake Maracaibo. E. R. Jackson, superintendent.

● **M-R Construction Company, Box 484, Wichita, Kansas.** Has 71 miles of 10-in. for *Great Lakes Pipe Line Company*, Kansas City to Burlingame, Kansas. John Tarpley, superintendent, Topeka, Kansas.

● **River Construction Corporation, 6100 Camp Bowie Boulevard, Fort Worth, Texas.** Has 66 miles, 8 and 12-in. gas line, Pecos County to Reeves County, Texas, for *Pecos Growers Gas Company*.

● **Ray L. Smith and Son, Inc., Box 391, El Dorado, Kansas.** Has 91 miles of 10-in. for *Great Lakes Pipe Line Company*, Burlingame to El Dorado, Kansas. Dewey Whitworth and Carl Colvin, superintendents, El Dorado office.

● **L. E. Farley, Inc., 5247 Buffalo, Houston, Texas.** Has 27 miles, 12-in. for *Transcontinental Gas Pipe Line Company*, Orange, Texas, to Texas-Louisiana border. L. W. Berton, superintendent, Cinton, Louisiana.

● **Foster-Wheeler Corporation, 165 Broadway, New York 6, New York.** Has overall supervision of a 1920-mile NATO pipe line system in Europe.

● **H. C. Price Company (Somastic Division), Box 1111, Bartlesville, Oklahoma.** Has contract for coating 163 miles, 10¾-in. OD pipe for *Great Lakes Pipe Line Company*. Railhead locations at Topeka and Emporia, Kansas. Has 84.8 miles (with Houston Contracting Company) of 36-in. in Alabama and Georgia for *Transcontinental Gas Pipe Line Corporation*.

● **Station Construction Company, Box 13174, Houston, Texas.** Has pump station for *Cherokee Pipe Line* products system, Jenks, Oklahoma; gas turbine compressor station, for *Trunkline Gas Company*, Edna, Texas; pump station and terminal, *Shell Pipe Line Corporation*, products line, Norco, Louisiana; terminal, *Standard Oil Company of Texas*, Albuquerque, New Mexico; metering stations, *Badger Pipe Line*, Rockford, Illinois.

New Office for El Paso Natural Highlights Hometown Skyline

El Paso Natural Gas Company has opened its new $5,000,000 home in El Paso. The 18-story buff brick has crystal gray Minnesota granite facing the main entrance of the building, and a lobby floored with gray terrazo and centered with the company emblem inlaid with red and yellow terrazo. Lobby walls are of buff Italian marble. All 16 elevator lobbies are walled with the same marble. A 10 by 20-ft color transparency covers the wall at the end of the street lobby floor.

The lobby alcove features a replica of the company's Midkiff, Texas, plant, and seven transparencies, 11 by 14 in., enclosed in mahogany frames. The pictures depict various company operations. There is also a map of the gas system, which is designed with ultra violet lighting which outlines the company's pipe lines and installations.

● **Panama-Williams Company, Melrose Building, Houston, Texas.** Has 120 miles, 12-in. for *Texas Company* in Colombia, S.A. Job temporarily shut down. Also has 93 miles of 5-in. products line for *Goliad Petroleum Corporation*, Texas City to Halletsville, Texas. H. Hall, superintendent, El Campo, Texas. Has 36 miles of 30-in. and 31.4 miles of 36-in. in South Carolina and North Carolina for *Transcontinental Gas Pipe Line Corporation*.

● **O. R. Burden Construction Corporation, 6702 East 21st, Tulsa, Oklahoma.** Has 50 miles of 8-in. products line between Cushing and Tulsa, Oklahoma, for *Texaco-Cities Service Pipe Line*. Has 31 miles of 30 and 36-in. in Louisiana for *Transcontinental Gas Pipe Line Corporation*.

● **Engineers Limited Pipe Line Company, 225 Bush Street, San Francisco, California.** Has 37 miles of 16 and 20-in. in Washington for *Trans Mountain Oil Pipe Line Company*.

● **Williams Brothers, National Bank of Tulsa Building, Tulsa, Oklahoma.** Has 160 miles of 6-in. for *Bolivian government*, oil line. Has 115 miles of 30-in. between Toledo and Cleveland, Ohio, for *East Ohio Gas Company*. Has 72 miles of 30-in. in Virginia for *Transcontinental Gas Pipe Line Corporation*.

● **Jess Whitlaw, Ponca City, Oklahoma.** Has 70 miles of 3 through 16-in. gathering system for *Pure Oil Company* in vicinity of Adena field, northeast Colorado.

● **Hallmac Construction Company, 2261 West Holcombe, Houston, Texas.** Has approximately 100 miles of 10-in. for *South Georgia Natural Gas Company*.

● **Buchanan Pipe Line Construction Company, Birmingham, Alabama.** Has 80 miles of 6 and 8-in. for *South Georgia Natural Gas Company*.

● **Cumberland Contracting Company, Monticello, Kentucky.** Has approximately 225 miles of 2 through 10-in. for *Southeast Alabama Gas District*.

● **Mid States Construction Company, Box 417, Mt. Vernon, Illinois.** Has 110 miles of 2 through 12-in. for *South Georgia Natural Gas Company*.

● **Associated Pipe Line Contractors, Box 13216, Houston, Texas.** Has 63.5 miles of 36-in. in Louisiana and Mississippi and 71 miles of 30-in. in Virginia and Maryland for *Transcontinental Gas Pipe Line Corporation*.

● **Midwestern Constructors, Inc., 402 North Boulder, Tulsa, Oklahoma.** Has 14.5 miles of 30-in. and 53.5 miles of 36-in. in Alabama for *Transcontinental Gas Pipe Line Corporation*.

● **Western Pipe Line Constructors, Austin, Texas.** Has 76.8 miles of 36-in. in Georgia and South Carolina for *Transcontinental Gas Pipe Line Corporation*.

● **Pipe Line Contracting and Drilling Company, P. O. Box 165, Lemoyne, Pennsylvania.** Has 46 miles of 26-in. in three loops in West Virginia and Maryland for *Atlantic Seaboard Gas Corporation*.

Annual NACE Meeting

New officers of the NACE are, left, Frank L. Whitney, Jr., St. Louis, president, and W. F. Fair, Jr., Westfield, New Jersey, vice president.

conference, exhibits attract 2500

DISCUSSION on corrosion problems and how to solve them reached a zenith in Chicago in March at the 11th annual conference of the National Association of Corrosion Engineers in the Palmer House hotel. Some 2500 persons attended the five-day meeting, which was highlighted by 60 technical committee sessions, presentation of 44 technical papers, and numerous discussion sessions as part of the technical program.

At the close of the meeting, new officers and directors took over the reins of the organization for the coming year. New NACE president is Frank L. Whitney, Jr., of Monsanto Chemical Company. W. F. Fair, Jr., Koppers Company, Inc., Westfield, New Jersey, was named vice president, and R. A. Brannon, Humble Pipe Line Company, Houston, was reelected treasurer.

Five new directors took office. They are Robert H. Kerr, Southern California Gas Company, Los Angeles, California; C. G. Munger, Amercoat Corporation, South Gate, California; O. E. Murrey, Midwestern Engine and Equipment Company, Tulsa, Oklahoma; Robert R. Pierce, Pennsylvania Salt Manufacturing Company, Philadelphia, Pennsylvania, and W. H. Stewart, Sun Pipe Line Company, Beaumont, Texas.

Frank L. LaQue, International Nickel Company, Inc., New York, accepted the Whitney Award in place of the honoree, W. H. J. Vernon of England, who was unable to be present. Dr. Gordon N. Scott, consulting engineer of Los Angeles, received the Speller Award. Both presentations were made at the annual banquet.

Organization of a group to study formulation and application of plastic film for pipe line coating was undertaken at the meeting, with R. B. Bender of Fort Worth, Texas, as chairman of the committee. The group plans to prepare a history of experience and results from use of prefabricated films.

At the pipe line general symposium, attendees heard reports on the proposed standard method for measuring conductance of coating on buried pipe lines, including discussion of methods to use and accuracy to expect, a review of methods of internal plastic coating of in-place line pipe methods and improvements needed; organization of corrosion program in pipe line companies from both personnel and technical standpoints, and a discussion of field and laboratory evaluation of pipe line coatings.

Ironing out of industry's corrosion problems was a function of the 60 technical committee meetings held during the conference. Shown is a typical session.

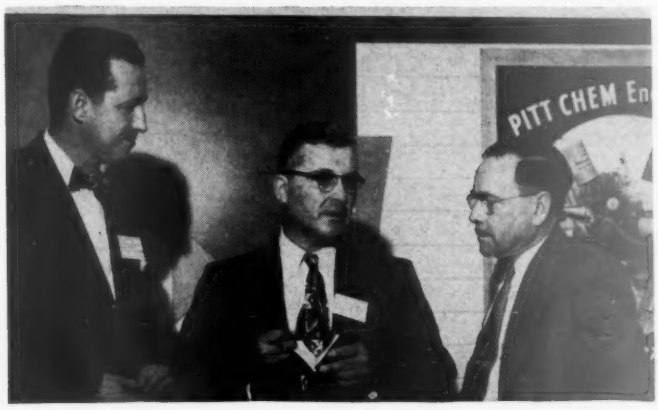
Fred Meyer, National Lead; F. J. Podlipec, National Lead; L. A. Breen, Barrett; F. Hieronymus, Barrett, and Jack Henry, C-R-C.

Coating problem being discussed by Sam Bosley, Fiber-Glass Ferro; A. F. Schnierer, Natural Gas Pipe Line, and N. T. Shideler, Pittsburgh Coke and Chemical.

Linden Stuart, Stuart-Stell Protection; Wayne D. Staley, Duriron Company, and Ralph J. Rice, Tretolite.

L. W. Ewing, Jr., Standard Oil Company of Indiana, general chairman of the convention; Ernest Liggett, Johns-Manville; Ed Noppel, Ebasco Services, and George B. McComb, St. Louis.

J. L. Moffett, Ohio Oil Company; A. R. Heidebrecht, Platte Pipe Line Company, and Ned Stearns, D. E. Stearns Company, discuss pipe line coating problems.



V. J. Scarola, left, Tapecoat, explains point to W. E. Ripley, center, New York Central system and J. F. Walsh, also of Tapecoat.

Phillip A. Meyer, Nicolet, left; Stephen Feeley, York, Pennsylvania, and Robert F. Driggs, right, Nicolet.

New developments are discussed by Jack Clemens, Dow Chemical Company; R. C. Schueler, Phillips Petroleum Company, and Hilary Humble, Dow.

Personals

▸ Promotions and transfers of key personnel in Pan American Pipe Line Company's operation department recently announced include appointment of **Edwin W. Kearns,** formerly division foreman of the West Texas division, to administrative assistant in Houston; **Paul B. Hayes,** division gager at Snyder, Texas, to division foreman, West Texas division; **Harold Hunt,** district foreman in the Reinecke area to division gager at Snyder; **David E. Luddeke,** division foreman at Tomball, Texas, to northern division at Longview; **James B. Johnson,** maintenance foreman at Raymondville at Alvin, Texas; **John F. Rogers,** Snyder warehouse foreman to maintenance foreman at Raymondville; **Robert J. Quick** has been promoted to warehouse foreman at Snyder; **Martin W. Pynes** to senior proration clerk; **L. B. Mulloy,** chief station engineer at Sterling City; **J. R. McMahon,** senior deliveryman at Tomball; **J. W. Wilhelm,** mechanical engineer, transferred to Longview; **Phillip J. Slover,** mechanical engineer, transferred to Houston; and **J. R. Burdette,** mechanical engineer, transferred from general engineering to operating department in Houston.

▸ **L. J. White,** superintendent of Magnolia Pipe Line's Houston, Texas, district, has been transferred to Beaumont as district superintendent of the newly-created Houston-Beaumont district.

▸ **J. R. Dean,** chief gager of Magnolia's North Texas and Olden districts, has been transferred to Beaumont as assistant district superintendent of the Houston-Beaumont district.

B. E. Lowe

E. E. Mayo

▸ **B. E. Lowe** has been named manager of sales for Trans-Canada Pipe Lines. Associated with the natural gas industry for 27 years, he was until recently a member of the firm of F. E. Shaw, Ltd., Sarnia, Ontario.

▸ **E. E. Mayo** has been appointed vice president of the recently organized Southern Pacific Pipe Lines, Inc. He has been chief engineer since 1944 of the SP's Pacific lines west of El Paso.

▸ **Albert T. Pasche,** of Magnolia Pipe Line Company's engineering department, has been transferred to Socony-Vacuum Oil Company, Inc., in New York as chief pipe line engineer of that company's producing department.

▸ **George A. Seymour** has been promoted to senior mechanical engineer of Magnolia Pipe Line Company with headquarters in Dallas, Texas.

▸ **J. S. Black, Jr.,** formerly district superintendent of Magnolia Pipe Line's Beaumont, Texas, district, has been transferred to Socony-Vacuum Oil Company of Canada, Ltd.

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The Changing Role of Management

Douglas McGregor

SIGNIFICANT threads have gradually made a pattern in the fabric of our industrial life. There have been broad changes in points of view that have affected management's role.

The first thread is a gradual realization that the successful operation of an industrial organization in a free enterprise system requires the willing collaboration of the people who comprise the organization. We haven't always felt this. In fact this idea wasn't at all common even 20 years ago. The notion that was common in management thinking in those days was that if the work was to get done people had to be made to do it.

Basic concept of motivation that we utilized was that of fear—fear of loss of employment and other forms of economic punishment were used to keep people at work.

Over these 20 years and more we have discovered that force in human affairs as in physics breeds counterforce, and the degree of ingenuity that human beings can exercise in the form of restriction of output, all kinds of subtle sabotage, militant unionism, etc., have long since taught us that if we attempt to use force the counter-forces will defeat the purposes we are trying to achieve.

So we have come around to realizing that fundamentally it is management's task to create the kind of conditions that will lead people to want to do the job, to collaborate willingly in achieving organizational goals. There are a great many evidences to be seen of the growth of this conception in management's thinking.

The use of communications programs and the importance that we place today on good communications up and down in an organization enable people to know what is going on, understand the changes that are about to take place, and be more willing to adjust to circumstances that they have to face.

And finally there is the general emphasis of management today on the whole subject of motivation, shifting around from the negative fear aspect to the idea of finding what kind of positive incentives will really get the job done.

The first thread has been a kind of trial and error thing. One company discovers, or some university puts out, some research that leads a company to try out a new method. It works pretty well and another company copies it. We like to keep up with the Joneses in this field as we do in other respects.

Gradually a lot of things happen but out of these specific details of practice and day by day policy is emerging something that is broader and deeper than any one of them and I think we are becoming conscious of this fact—that willing collaboration of everybody in the organization from the board of directors to the janitor is essential if we are going to get the kind of output and the kind of economic result and human result we are seeking.

The second thread in the fabric of our industrial life is another attitudinal thing. It's a growing feeling of confidence on the part of management in the potentialities of people. We don't any longer hear management talking about employees as hands. Labor isn't any longer seen as a commodity.

We've come to see people genuinely as individual, whole human beings who have remarkable potentiality—potentialities that we haven't really touched at all in industry up to now.

I don't mean this in the narrow sense of how many Btu's of energy man puts out. This is important but we tend to overestimate it. What I'm talking about is the kind of potentiality that we sense when we talk about ingenious, creative minds who can be encouraged one way or another under the proper circumstances to help make an enterprise more successful.

This kind of ingenuity and creativity is characteristic of our civilization. It is characteristic of the janitor and the benchhand as well as the director of research and the vice president. We are only beginning to tap these potentialities.

Twenty years from now, we'll probably look back on our present attempts as very clumsy and inept but again there is evidence that we are groping in the right direction. For example that whole area concerned with decentralization, delegation, and authority wouldn't come about if we didn't have a kind of confidence in people which was lacking even a few years ago.

The concept of decentralization and delegation means we have enough confidence in a man to outline the broad range of responsibility and authority we hand him and then turn him loose and let him find the way to do the job without supervision in its narrow sense. This kind of relaxation of control is possible only because we have come to have genuine confidence in people and what they can do.

This same concept recently has carried still lower in the organization and we are hearing a lot about job enlargements. To be sure job enlargement has been partially forced by the process of automation because the people who deal with the automatic process must exercise a different and higher level of judgment. People have to be upgraded. We are beginning to realize that the worker is capable of a job that has meaning in which he exercises judgment and can acquire skill. And so job enlargement is coming back to replace the excessive specialization characteristic of the last few years.

The practice of participation is another one which is bandied around a lot today in industry, representing once more a growth in the feeling of confidence in people and their potentialities. When this idea was first introduced, 10 or 15 years ago it came in the context of the good old phrase, "Democracy in Industry."

If you free people from the restraints of authoritarian control under the proper circumstances and motivation they can help to create a better society. This idea built into the industrial organization is the concept of participation which we are gradually exploring and finding to be very fruitful. We have a great deal more to learn here about the limits of participation and about its potentialities, but the point I make is simply this: We wouldn't even be playing with the idea if our attitudes hadn't shifted.

The field of executive development is another illustration of confidence in people. Instead of seeking for top management out of a very small strata of our industrial society we are saying more and more that potentialities latent in people can be developed so that many more people can become capable of top management responsibilities.

As a U.S. delegate, I attended a 13-

This is a condensation of an address given before the Southwest Regional Conference sponsored by Southwestern Alumni Clubs of Massachusetts Institute of Technology in Dallas, Texas, January 29, 1955.

Three threads have changed the fabric of our industrial life:

1. ***Change to better motivation***
2. ***Recognition of potentialities of people***
3. ***Self-confidence of management***

The Author

Douglas McGregor received degrees from Wayne and Harvard Universities and taught at Harvard for two years before joining the Massachusetts Institute of Technology faculty in 1937. A founder of the Industrial Relations Section, he was its executive director from 1946-48. After five years as president of Antioch College, he returned to MIT in 1954 as professor in the School of Industrial Management.

During World War II, Doctor McGregor served with several Government agencies as labor relations analyst and arbitrator. He has for many years been a consultant to both companies and unions in the East and Middle West.

nation conference in England on the subject of executive development. Our European friends are only just beginning to catch today a concept which is pretty familiar to us after 15 or 20 years. They attempt to draw their top management potential from a very narrow segment of the society on the assumption that the other people didn't have the potentiality. And it was only when this dried up to the point that they could no longer get what they needed that they began to look lower down in the organization.

Then finally in this connection I refer again to our emphasis on communications. When we attempt through a program of communicating with employees to tell them what we are about and why, we are saying that if they understand we can have confidence in their good sense. Otherwise we would not bother to tell them.

One big company has developed a series of films as an economic education for employees to show how the company operated, what its philosophy was, and how it fitted into the broad economy. After this set of films was shown to people throughout the organization, I talked with one of the executives about the problem of evaluating the effects of it. Instead of talking about before-and-after attitude measures, he said that he wished that there were some way to determine whether people who had seen these films will take more variables into account as they look at complex phenomena in our society.

Now, you don't talk that way unless you've got a pretty high level of confidence in the common sense and intellectual ability of the average person. He was saying people are bright enough, smart enough, and sensible enough so that if they just see how many variables there are here they will arrive at the right kind of answers and I'm not worried whether they arrive at the same answer I did.

Again this thread—growing confidence in people and their potential—hasn't been the result of a logical plan. The confidence is emerging out of trial-and-error experience in dealing with people instead of defining management as we used to: "It's the direction and control of the elements of production, money, machines, processes, and incidentally, people," we are saying more and more.

> **"Management is the conservation, the development and the utilization of the human resources in industry." The emphasis is on the word "resources."**

The third and last thread in this picture is that of management's own self-confidence. Say 40 years ago I think it would be fair to say that the dominant characteristic of top management in our society was that of arrogance. They were on top of the heap.

Perhaps some of you have seen Adolf Berle's new book on the American capitalist. It's the second one he has written in which he has pointed out the power that big corporations have in our type of economy but there is an interesting change in his point of view in this book as compared to the one he wrote a few years back. Today he says he can see little if any evidence of management of our big corporations wielding tremendous power potentially detrimental to the society, because they are exercising self-restraint.

This is evidence of the kind of emerging self-confidence that is making management into a real profession today. I've had the fascinating experience for the last three and a half years of serving on a committee of the Standard Oil Company (New Jersey) which is called the Advisory Committee on Human Relations. This committee, composed of 8 or 10 people including directors of the company, concerns itself with the social responsibilities of the corporation; the problems affecting human relations on which the company needs to be thinking. This kind of restraint and thinking and concern is evidence again of management's growing self-confidence.

Let me point to these things: First, management's willingness today to exercise authority in the real sense of that term—exercise authority with a readiness to accept the consequences. We are no longer as arbitrary as we once were. On the other hand we haven't done what we did during the depression and post-depression days when management was facing the tremendous problems of militant unionism and so on. Then, swung between a highly authoritarian concept and anarchy for a while—management simply abdicated in many instances.

We have come back to a balanced middle position in which management is willing to make decisions, to absorb the uncertainties which go with making complex decisions, and to accept the inevitable hostility that goes with the exercise of authority, because you can't please everyone.

It has come to accept the notion that conflict and disagreement in human organization is inevitable. We've gone through a long period of searching for sweetness and light. Everybody is going to agree with everybody, everybody is going to love everybody, nobody is ever going to quarrel about anything.

If we had organizations like that they would be completely dead on their feet. It's only in the organization where people can disagree, where new ideas can come up and be knocked down and be thought about, where people can differ sharply and sincerely about important issues, that you get growth and development and vitality. To seek for peace as a condition of health is basically nonsense. We have to be able to cope with disagreement and conflict, keeping it within confines to be sure, but encouraging it if we are going to have healthy

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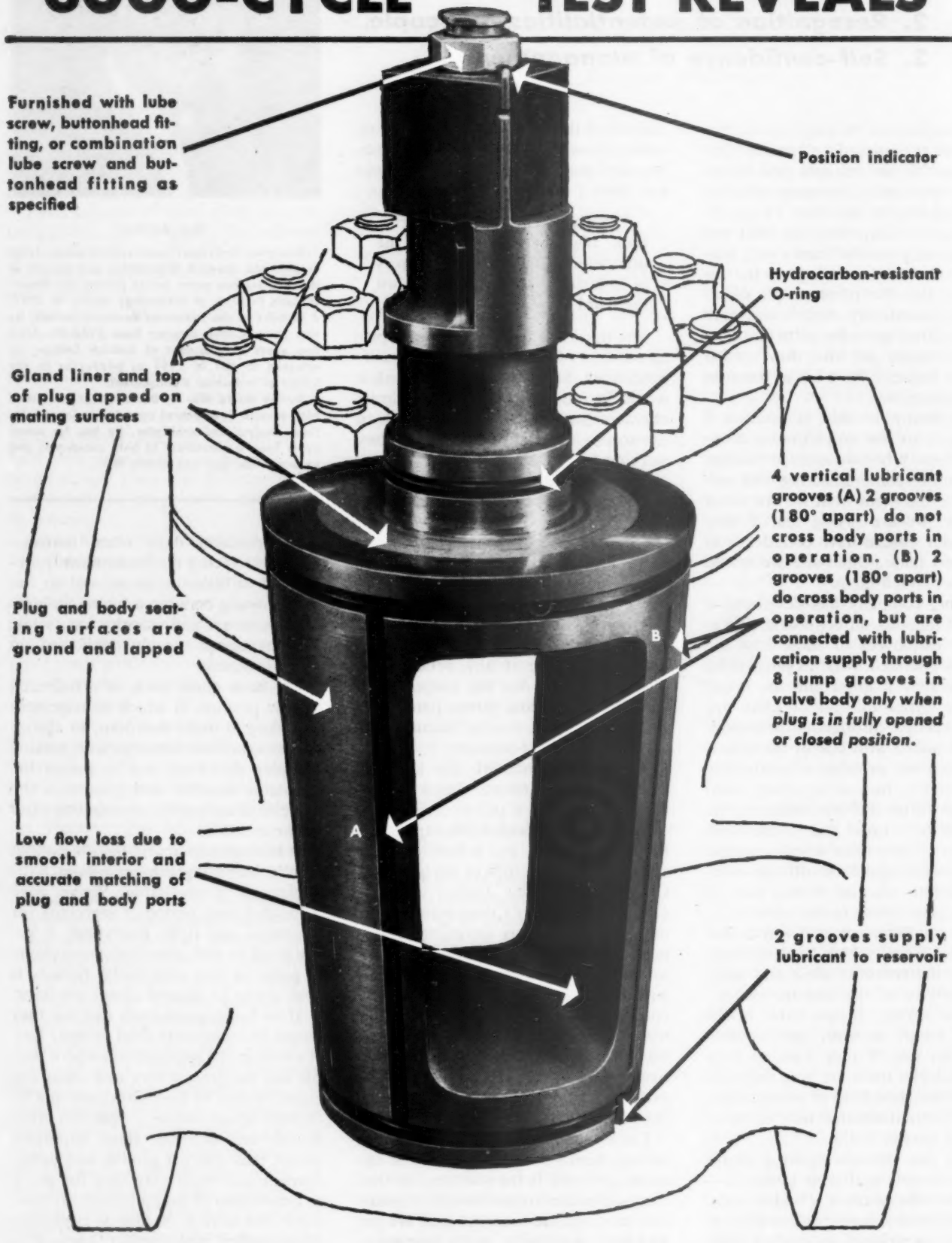
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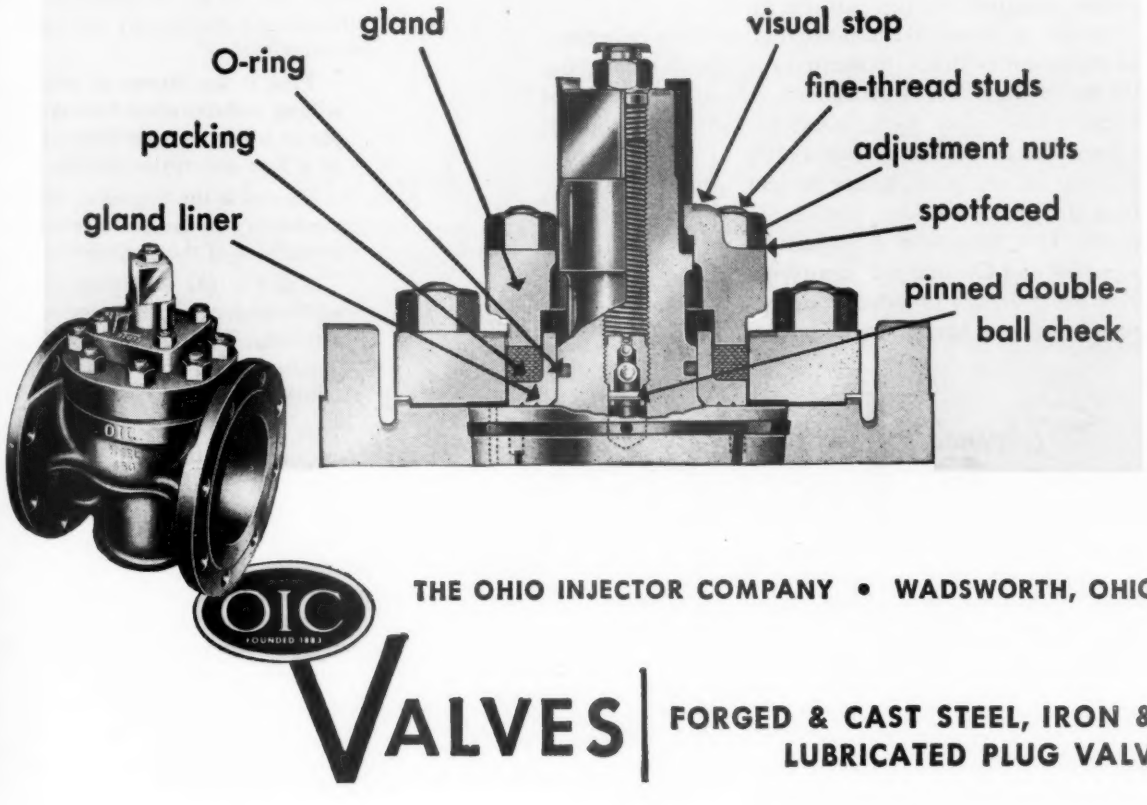

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P.S. *The cryptic headline is from the Roman poet Horace (Odes II, xiv. 1). Its literal translation is "Alas, the fleeting years glide by," but we cannot echo the poet's expression of regret.*

DICALITE DIVISION, GREAT LAKES CARBON CORPORATION,
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organization. Management is now concerned with the problems created, for example, by promotion-from-within policies, raising the question, are we getting enough new blood in the organization? Are we permitting the person who is the porcupine to grow, develop, and mount in the organization?

If we create a mold in which we all think alike, everybody agrees all the time with everyone, we are not going to be able to meet the kind of problems that face us.

Finally, one more evidence of management's self-confidence is the fact that the line manager more and more is accepting full responsibility for personnel administration in the company. For a long time there was a real attempt to get rid of this kind of responsibility, to get the expert in and let him deal with the people. It wasn't just that management was too busy; it wanted to avoid difficult and complex and sometimes frightening problems.

We know now that you can't operate an organization that way. The line staff has its function and it is an important one, but it has got to be responsible for dealing with people. Management means getting things done through people and there is no escape from that. Until we face the fact squarely and take the responsibility for personnel administration, we haven't begun to deal with management problems.

Let me try then to summarize. I've talked about three permanent threads in the fabric of our industrial life which seem to be emerging as patterns today. These threads are all elements of basic attitude and philosophy on the part of management.

First is the thread of achieving willing collaboration between people as a way to gain the objective of a free enterprise system.

Second is the thread of growing confidence in the abilities and potentialities of the ordinary man.

Third is the emerging genuine self-confidence of management itself—the kind of self-confidence that includes a good portion of humility and social conscience.

This sort of thing isn't true of all management nor of all individuals within any given management. These things only gradually get built into a system but these three threads are beginning to have a profound importance in our free enterprise system.

By and large and over the long run, management gets the kind of organizational effectiveness that it deserves. Management in this country is beginning to get an altogether new kind of relationship from the people that comprise our industrial organization. * *

The Petroleum Industry

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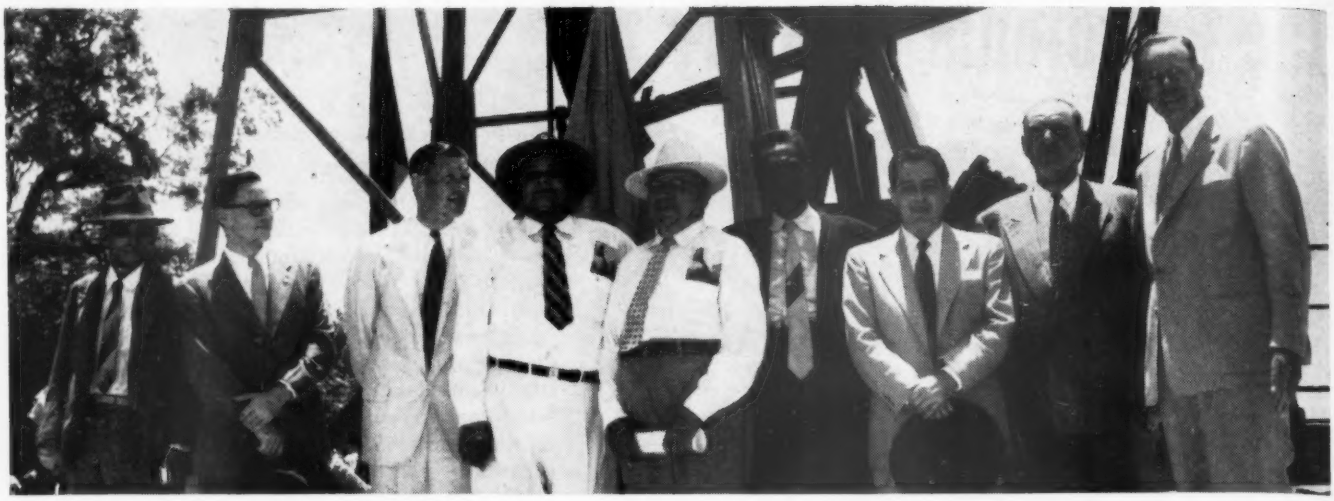


Celebrating 40th Anniversary of Mene Grande No. 1. Left to right, Julio Ballesteros, who helped to drill the original well; G. C. K. Dunsterville, vice president of Cia Shell de Venezuela; W. F. L. G. Starrenburg, assistant manager and director; Samuel Smith, employed in Mene Grande in 1914, and now assistant head of materials department; Ensebio Sandrea, employed in Mene Grande in 1914, now retired after 41 years of service; Alcibiades Colina, employed in Mene Grande in 1914 and now production foreman in Cabimas; Gustavo Thery Fombana, director, Hydrocarbons office, Ministry of Mines; Enrique Jorge Aguerrevere, engaged in Mene Grande in 1914 and former minister; and I. D. Davidson, president, Cia Shell de Venezuela. To mark the well's 40th year, a plaque was unveiled at the well site. Part 1 gives the background of discovery and development of oil reserves.

VENEZUELA

Four Decades of Progress

TRANSPORTATION

The first pipe line in Venezuela was built by Shell in 1917. Trunk pipe line capacity crept slowly, being only about 300,000 bbl a day in 1938. Since then, however, this capacity has increased more than 5-fold, and now exceeds 1,500,000 bbl a day. This rapid growth of trunk pipe line capacity was brought about by 3 factors. First, the need to reduce transportation costs in shallow-draft tankers operating out of Lake Maracaibo to Las Piedras and Aruba made a pipe line to Paraguay Peninsula attractive. Second, exploitation of interior oil fields rendered necessary the construction of lines in eastern Venezuela. Finally, the requirement to consolidate high cost tanker terminals and reduce terminaling costs.

The Ute-Amnay Pipe Line was built in 1947-48 to transport Creole's medium crudes from the Tia Juana area to Amnay Bay for its refinery and for export in ocean-going tankers to Aruba and other parts. The total length of this 24- and 26-in. line is 143 miles, and it includes 2 pump stations and a terminal. The line capacity is 300,000 bbl a day at the operating pressure of 875 psi. The company recently commissioned a parallel 26-in. line and one additional pump station at Ute to step up the total pipe line capacity to close on 481,000 bbl a day. Its 14,000 bbl a day Mara production is delivered by a jointly owned pipe line system to Shell's Palmarejo terminal. It has a capacity of 138,400 bbl a day.

A shipping terminal at Caripito and an 11-mile 8-in. line were completed in 1930 and the Quiriquire field was placed on production. Later, a complete loop of 10-in. and a short section of 16-in. line was added to give a total capacity of over 80,000 bbl a day. Creole also executed a section of 20-in. line to connect with the short section of 16-in. line. This combined 16- and 20-in. line now handles all Quiriquire production. The 8- and 10-in. lines have been converted to gas service to supply gas to the Caripito refinery. The Jusepin crude is delivered by a 46-mile 10-in. line built in 1939 with a capacity of 37,000 bbl a day.

The Temblador field production is pumped through a 34-mile 10-in. line to a terminal at Boca de Uracoa. It has a capacity of 40,000 bbl a day. This pipeline and the Boca de Uracoa ter-

SECOND OF TWO PARTS

V. S. Swaminathan describes the growth of refining and transportation — the development of legislation and the great benefits that have resulted from sound handling of the expanding oil industry.

Tugs tow diesel electric power barge destined for drilling by Shell in Lake Maracaibo.

minal are jointly owned by Creole (79 per cent) and Mene Grande (21 per cent) with the former operating. Creole also owns a part interest in all of the Mene Grande-operated trunk lines in eastern Venezuela, which transport crude to two deep-water terminals and refineries.

The Venezuelan Atlantic Transmission Corporation, formed in 1950, was awarded a contract for the construction of a 220-mile line for the transmission of natural gas from its Placer field in the Guarico State to Valencia and the Caracas-La Guaria area. It is the country's first major gas transmission project. Originating in central Guarico its terminals are at Caracas, La Guaria, Arrecife, Santa Lucia and Valencia. This project's design capacity is 70 MCF a day at an inlet pressure of 800 psig. The main line is 190 miles in length, gathering lines 70.26 miles and laterals 50.89 miles.

A unique feature of the main line and gas gathering systems is that they incorporate internal corrosion control necessitated by the relatively high CO_2 content of the gas. The gathering system is protected by the injection of Kontol solution both in the wells and in the lines. A dehydration plant has been installed in the Guarico terminal of the main transmission line to reduce the water vapor content of the gas to remove the internal corrosive effect of the combination of free water and CO_2.

Venezuelan natural gas is not a readily exportable product like crude and finished products. But an assured supply of gas of uniform quality at an attractive price over a long term cannot fail to stimulate the establishment or expansion of industries.

The network of pipelines spreads over five states in the country: Anzoategui, Falcon, Guarico, Monagas and Zulia and the Territorio Delta Amacuro. In 1953 a new natural gas grid was completed at a cost of $15 million and involved laying 250 miles of pipe of varying diameter up to 16-in.

From an international standpoint the oil tanker ranks first as a method of transportation, and in Venezuela, the leading tankers have capacities ranging from 80,00 to 250,000 bbl, and shallow draft tankers used mainly for moving oil from Lake Maracaibo. In May 1953 dredging operations entailing $14½ million began on the entrance of this lake. On completion Lake Maracaibo will be accessible to ocean-going vessels.

REFINERY EXPANSION

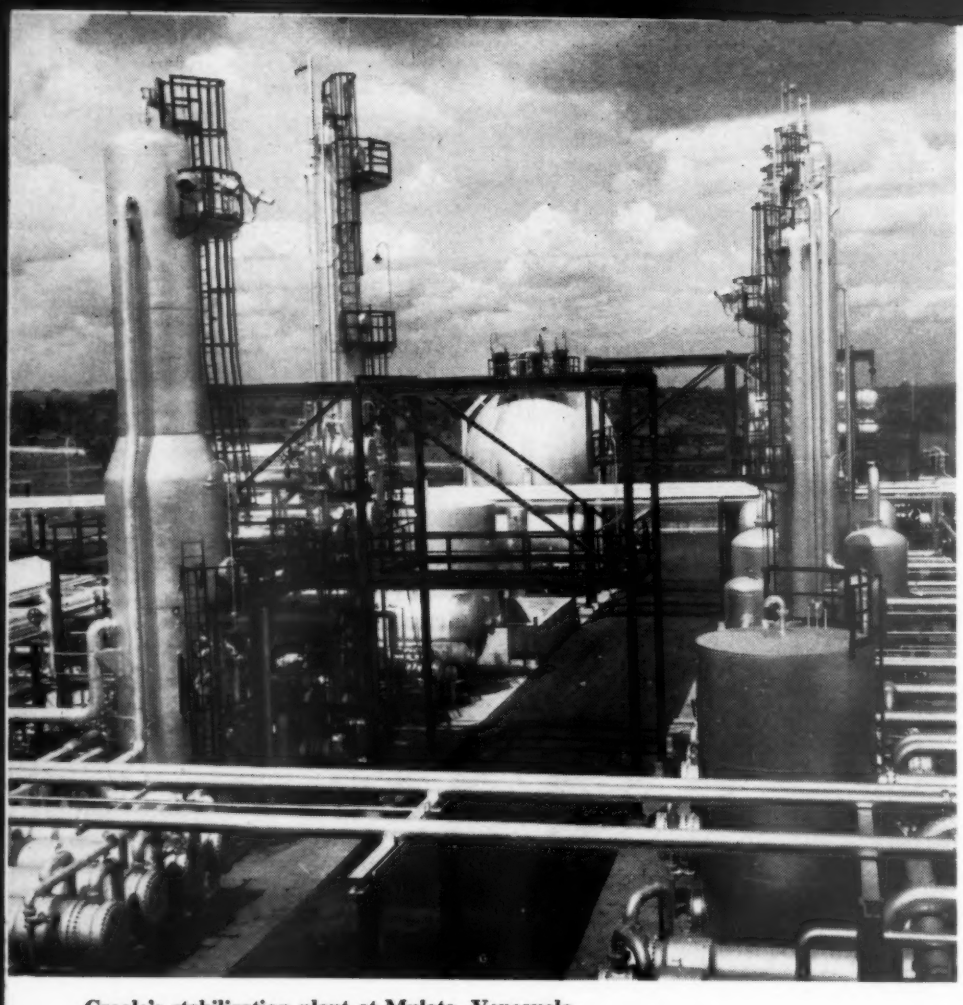
Venezuela's refining history dates back to the operation of a small tea pot refinery in 1880 at La Petrolea. After a long interval a 2000 bbl a day commercial plant was commissioned at San Lorenzo in 1917, followed by the construction of several small refineries in the 1925-31 period. Further expansion during 1938-39 resulted in a jump in refining capacity to 79,000 bbl a day in 1939. Four large modern plants were completed later raising the country's throughput to 290,000 bbl a day by 1950. Today it has gone up to 497,000 bbl a day.

A host of products are made by the various refineries including gasoline, bottled gas, aviation turbine fuel and lube oils. Processes they employ embrace two-stage crude distillation, vacuum distillation, thermal cracking including Dubbs cracking and visbreaking, reforming, polyforming, hydroforming, phosphoric acid polymerization and several treating methods. Leading oil companies have given practical support to the government policy of refining domestic crude within the country by erecting new and expanding existing facilities.

The Shell Cardon refinery, the industrial area, and the residential sector occupy 3200 acres on a once barren and wind-swept tract of land in the southwest corner of the Paraguana Peninsula. This particular site was chosen because it is the nearest deep sea-water site to Lake Maracaibo oil fields. In addition, the 50-ft cliffs forming the shoreline, shelter the harbor from the northeast wind blowing across the peninsula with considerable force for most of the year. Largest integration installation in South America, the Lummus Company designed the crude oil distillation units, high vacuum and gas separation plant, doctor treater, redistillation unit and lubricating oil plants. Univeral Oil Products was responsible for the cracking units, the reforming plant and polymerization unit, while N.V.de Bataafsche Petroleum Maatschappij accounted for the acid, phosphoric and soda treaters.

The first installation—crude unit No. 1—came on stream in February 1949, less than 4 years from the date the first party set foot on the site. By the end of 1950 the following major units were completed and operating: A doctor-treating plant and ethyl-blending plant, a vacuum distillation plant, redistillation unit, cracked product separation plant, two thermal cracking units and a thermal reforming plant. At the time the project had already cost $140 million and consumed more than 200,000 tons of steel.

In the early stages, crude oil from Shell's fields in Western Venezuela was delivered by shallow draught tankers. Later, it began reaching the refinery through the 30-in. pipe line connecting the oil field terminus of Palmarejo, north of Lake Maracaibo to Cardon. This pipe line is 163 miles long, and includes two submarine crossings, one at the Gulf of Coro and the other across the neck of Lake Maracaibo. It is jointly owned by Shell Caribbean (89 per cent), Texas and Mene Grande.



Creole's stabilization plant at Mulata, Venezuela.

Work on the new extensions began in the first half of 1951, the additional facilities comprising a new distillation unit and modifications to the existing similar unit. The foundations of a second crude distillation unit of 52,000 bbl a day capacity were laid in June 1954. Coupled with modifications to step up the crude capacity of the first crude unit and conversion of the redistillation installation to treat crude, capacity of Cardon refinery was raised to 170,000 bbl a day.

Initial operation for the first unit of Creole's refinery, a 60,000 bbl crude distillation plant was commissioned in early 1950. This atmospheric unit produced the conventional overhead products: Gasoline, naphtha, kerosine, and light gas oil aggregating 41-45 per cent of the crude charged. A vacuum still was brought on stream during the third quarter of that year charging the 55-60 per cent reduced crude, further reducing it to a bottom residual fraction equivalent to 26 per cent of original crude, and produces intermediate and heavy gas oil as distillate.

An asphalt plant was incorporated to serve domestic demand and it accounts for both cutback and oxidized products. This unit now has a daily output of 4300 bbl. The Amuay refinery also accounts for a line of straightrun fuel products, treated conventionally and finished for marketing. The company has invested nearly $36 million on the construction of a new plant at its Amuay Bay refinery. The added installation will double its capacity and enable 75 per cent of the output to be exported. Plant additions will facilitate avgas to be manufactured by a fluid hydroformer of 10,000 bbl a day capacity and this will be the first unit of its kind in the world.

Subsidiaries of two major American companies—Gulf Oil Corporation and The Texas Company, hold a joint interest in the 30,000 bbl a day Puerto La Cruz refinery in Anzoategui in eastern Venezuela. This unit was initially designed for 20,000 bbl a day throughput, an exclusive Venezuelan Gulf Refining Company operation. A later pact with The Texas Petroleum Company and its associate S.A.P. Las Mercedes provided for expansion to 30,000 bbl a day, with Gulf and Texas interests amounting to ⅔ and ⅓ respectively. Crude runs and refined items will be shared by the companies in the same proportion.

Commissioned in 1950 this refinery featured the first use of polyform process for cracking heavy gas oil with high gas diluation to maximize yields of higher octane gasoline. The adaptation of the process arose from pilot plant work conducted at Gulf research laboratories at Harmarville.

The fourth new major installation is the 35,000 bbl a day Puerto La Cruz plant of Venezuelan Petroleum Company, a Sinclair subsidiary.

Major Venezuelan Refineries

Location	Ownership	Capacity bbl/day
West Venezuela		
San Lorenzo.....	Shell	44,000
Cunta Cardon.....	Shell	170,000
Amnay.....	Creole	136,000
East Venezuela		
Puerto de la Cruz...	Mene Grande-Texas	55,000
Puerto de la Cruz...	Sinclair	35,000
Caripito.....	Creole	70,000
Tuenpito.....	Texas	10,000
San Roque.....	Phillips	2,000
Average daily refining.....		297,000

In his message to the Venezuelan National Congress last April President Perez Jiminez disclosed plans for the setting up of a chemical industry based on gas. For a start it is envisaged to produce ammonia and fertilizers; later, chlorine, caustic soda and insecticides and eventually ethylene, propylene, glycol, benzol, plastics, dyes, detergents, solvents, etc. It is computed that 30-40 per cent of the entire output of the future Venezuelan petrochemical industry will be fertilizers.

OIL LAWS

In late October (1954) the Venezuelan Government received bids for the first oil concessions to be granted for almost a decade. Areas offered were the so-called "free" acreages not previously under concession. They exclude the national reserves comprising mainly of the 50 per cent acreage required to be turned back to the government when they are converted once production is found. Concessions offered include large areas of major exploratory interest in all parts of the country: eastern Venezuela, the western section, the Barinas—Apure basin, Gulf of Venezuela and the highly productive Lake Maracaibo itself. Although bids had not been revealed, one estimate is that bonus offers tendered to the government would run into several hundred million dollars. Additional millions would be bid if the government would offer the national reserves or part of them as it is expected to do in the near future.

In addition to the 11 companies now operating in Venezuela several other U.S. concerns are stated to be in on the bidding, including Cities Service Company, Superior Oil Company, Southern California Petroleum Corporation, and Conorado Petroleum Corporation. Another possible newcomer is Tide Water Associated Oil Company. In addition, French interests are understood to have tendered offers. It will take almost a year before any concession grants are made on the offers already submitted.

In taking this rather belated step, the

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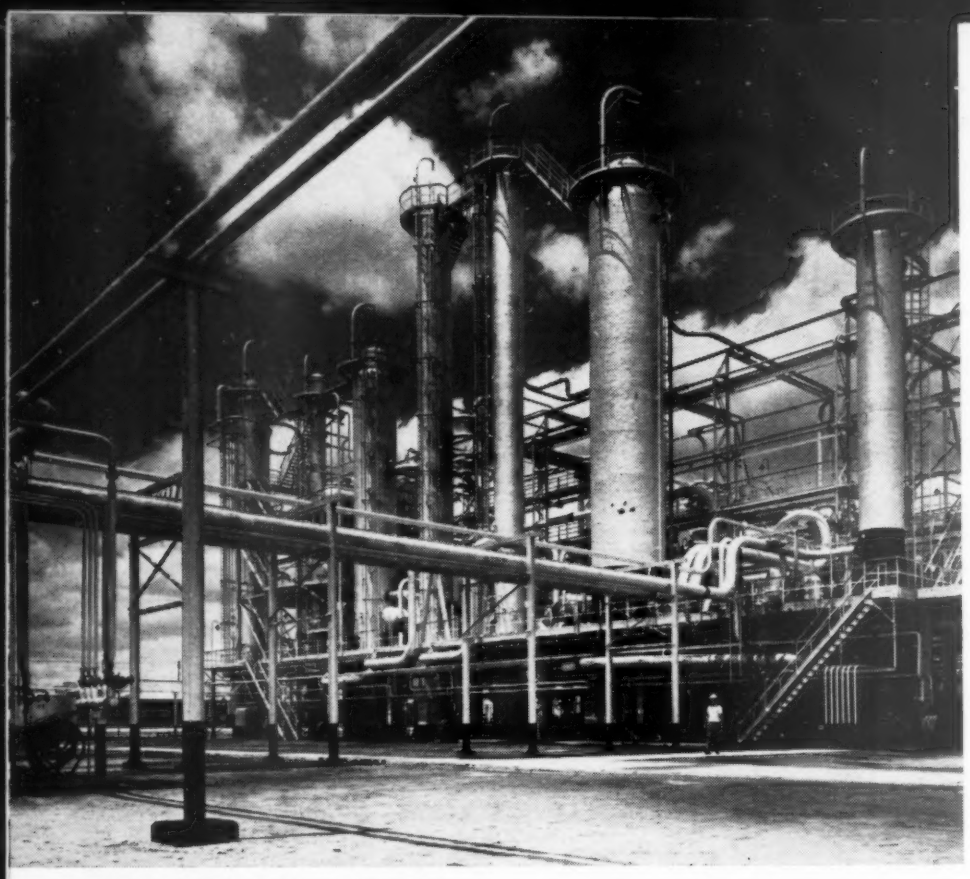


Shell gas plant at Mara, Venezuela.

Venezuelan Government is, from a short-term angle, apparently after substantial revenue. Although the direct revenue from current domestic petroleum operations is of the annual order of $400 million. The country is in the throes of a major public works program, and ever larger sums will be needed for these improvement projects. Nearly 36 per cent of the Venezuelan oil is sold in the United States, mainly heavy fuel oil dovetailing into the American pattern of production and processing operations. Concession conversions during the past 9 years have left operating companies in Venezuela with mostly exploitation acreages. Finally, although local operational costs are on the high side, this country provides the most attractive areas in Latin America for oil exploration and development.

OIL LEGISLATION

The prime requisite to success in oil finding is the freedom to explore, and only slightly less imperative is freedom to develop and produce the oil once it is found. As Venezuelan oil legislation evolved, from the old *Codigo de Minas* of 1907 to the *Ley de Hidrocarburos* of 1943, taxes have gone up and greater control has been introduced in various phases of the industry, but the provision that "any person, national or foreigner . . . may freely explore and carry on geological or geophysical investigations . . . in the national territory" has remained unaltered. By contrast in Brazil and Colombia, where exploration has been restricted by antiquated or harsh and ultra-nationalistic legislation, the petroleum industry has not prospered to the same extent as in Venezuela. The principle of the ownership of the subsoil minerals by the nation and the regulation of their production by the State has been sustained throughout the life of the republic.

The first Petroleum Ordnance enacted in 1918 provided that the rights of exploration and exploitation of asphalt, petroleum and other hydrocarbons could be acquired only through special contracts granted by the Federal Executive. The latter has a discretionary power in the granting of concessions, and generally these are granted to responsible operating companies, with the means for exploring and developing the area promptly and adequately. The 1922 Petroleum Law established the basic principles of the present Venezuelan oil legislation which has enabled the development of the industry to the point where the country has become the world's second largest oil producer and premier exporter.

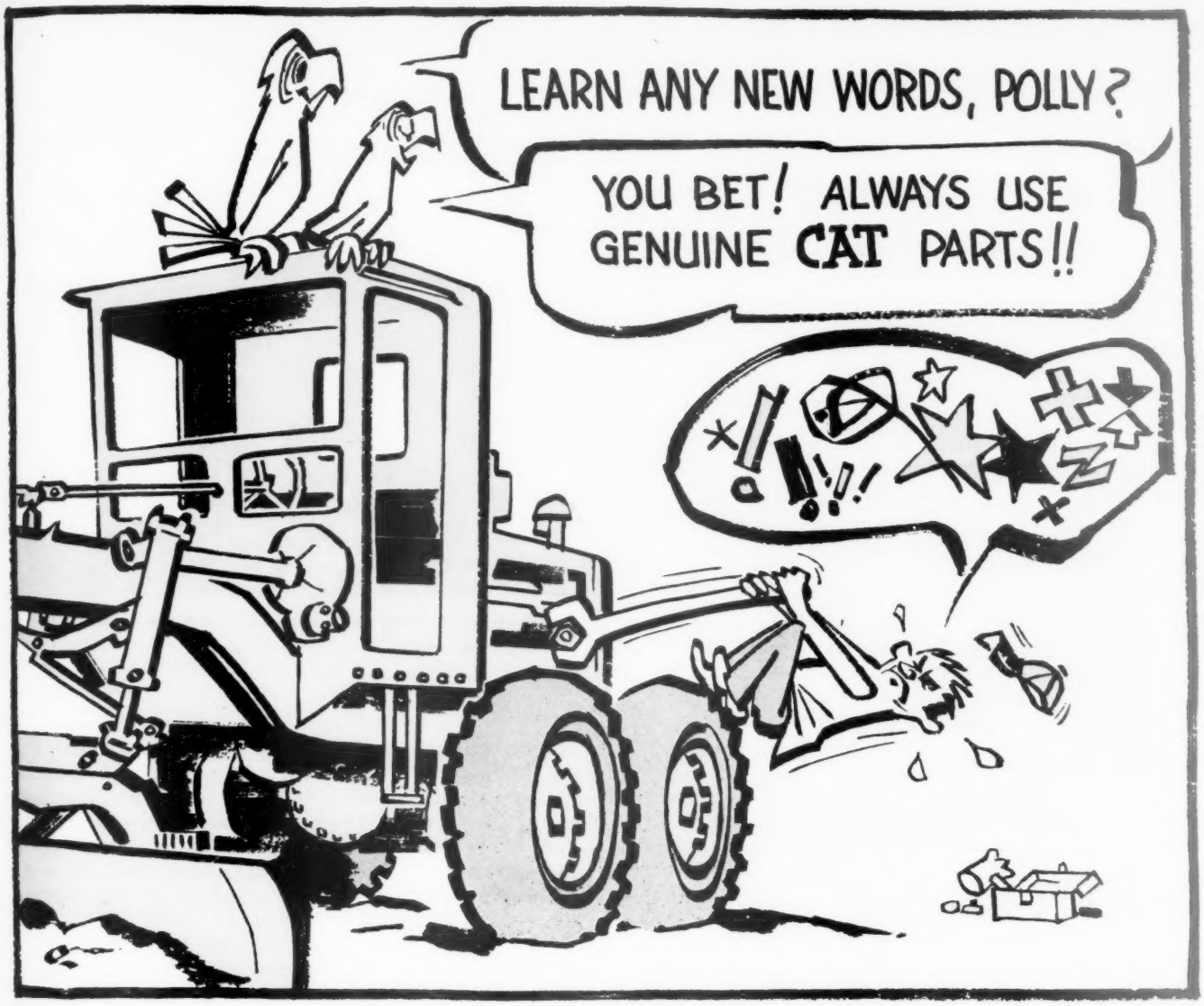
But the fact that oil concessions were governed by different petroleum laws, with varying provisions pertaining to inspection of production and ways of computing taxes, made for confusion, and the need for standardization of rights and obligations for all oil concessions was keenly felt. An agreement was finally reached in 1942 between the Government and operating companies on terms under which all oil concessions would be converted to a uniform status. The result was the enactment of the Petroleum Law of 1943 by the Venezuelan Congress and the oil companies altered all their concessions to accord with it.

The 1943 Petroleum Law authorizes granting by the Government of concessions for the following purposes: (1) Exploration of specified lots not exceeding 24,710 acres, with the inherent right, after 3 years of exploration, to exploit an area up to a maximum of one-half the initial exploration area. The other half reverts to the State as National Reserves. (2) Exploitation of specified plots not exceeding 1235 acres. The exploitation concession does not carry the obligation to drill in search of oil, but an annual tax per hectare must be paid, and this tax is increased periodically. (3) Manufacture and refining of petroleum. (4) Transportation of oil, gas, etc., and of products derived therefrom. Concession items 3 and 4 may be granted separately, but they shall always be deemed annexed to the exploitation concession.

The following is a list of the important direct taxes the oil industry is called upon to bear: (1) Exploration tax of two bolivars per hectare per annum during the three years of the exploration period on exploration concessions. (2) Initial exploitation tax of 8 bolivars per hectare as minimum, which may be considered the actual purchase price of the concession. (3) Surface tax on exploitation which is increased periodically during the 40 years' tenure of the concession. (4) Exploitation tax (Government royalty) fixed at 16⅔ per cent of crude oil extracted as measured in the producing field. The same tax applies to natural gas, even to that used as fuel in producing operations. (5) Tax on refined products used for consumption within the republic equal to 50 per cent of import duties which they would have yielded had they been imported. This tax does not apply to products refined in the country for export.

In addition, oil companies must pay all other general taxes—income tax, import duties on imports, consular duties, revenue stamps, etc.

An amended income tax law published on November 12, 1948, provided for an additional tax to be levied on oil companies and other industries holding concessions for the development of national resources whose net profits exceed taxes paid to the Government, provided such companies have earned more than 10 per cent on their invested capital. In arriving at the amount of additional tax the companies are allowed credit for other taxes paid, including import duty, concession surface tax, exploitation tax (royalty)



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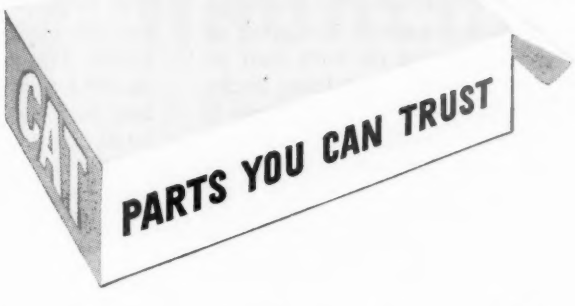

normal income tax and complementary income tax.

In 1953 concessions were held on 15.5 million acres, accounting for around 17 per cent of Venezuela's sedimentary basin area or 6 per cent of the entire country. Of this aggregate acreage just over 57 per cent was held by the "Big Three"—Creole, Shell and Mene Grande. Advocates of throwing open the country to new grants have argued that considerable oil capital normally interested in Venezuela is now moving into Peru and Canada and that, moreover, the policy of holding domestic oil reserves for long-term future is fallacious in the light of the vastly greater reserves of the Middle East and the possibility of the development of other resources like atomic energy.

Largest oil pipe line in South America being laid across Gulf of Coro between Maracaibo fields and Shell's refinery at Cardon.

OIL BRINGS BENEFITS

Oil has a habit of appearing in inaccessible and inhospitable areas and Venezuela is no exception. Before the industry arrived neither the swamps east of Lake Maracaibo, the bush west of the Maracaibo city nor the savannas of Anzoategui held any considerable population. The companies have had to build their own roads, their own towns, schools, hospitals and shops, to lay electricity and water, and take elaborate measures to safeguard the health of employees. Apart from the exacting welfare requirements laid upon them by the Government and providing such other services as conditions warranted, it has been estimated that the companies must find approximately $5,000 a year per worker. In addition to his pay packet each employee receives holiday pay, a share in profits, medical benefits and on termination of his employment a handsome severance grant. His family obtains free education, housing, and the right to use shops where foods and many other essential commodities are sold at controlled prices; the companies subsidize these to the extent of Bs. 25 million a year. In fact, the oilfield workers—93 per cent of them Venezuelan—form a small welfare state.

Even more arresting has been the creation during the past decade of new communities in the desolate Paraguana Peninsula. Against a flat Salvador Dali landscape in which only the cactus defies the unceasing winds two great refineries have sprung up, with their attendant tank farms, pipe lines, docks, and township. Their water supply is piped for 60 miles from hills south of Coro on the mainland at a cost of $10 million.

The Venezuelan oil industry employs only some 3 per cent of the gainfully employed population. In addition to providing a vast increase in national income and opening up the country with modern transportation facilities, it has provided byproduct of great and growing importance—natural gas. The oil companies have, indeed, made a major contribution to the republic's progress in health, education, communications, transportation facilities and farming since they have opened up sparsely populated interior regions not previously accessible and developed excellent communities there for their employees.

The petroleum corporations have built their own roads when necessary. These total nearly 1500 miles of paved highways maintained by the companies but used as public thoroughfares. Five of the 15 airfields built at camp sites are utilized by commercial lines and can take care of four-engined aircraft.

The rosy picture of the country's economy, overwhelmingly dependent on oil, has its sombre side. The shock which Venezuela received in 1949-50 when oil prices fell for a time by nearly 25 per cent sufficed to dispel complacency. The uninterrupted expansion of the industry was checked for the first time since 1941, and the effects on the national economy were profound. The value of exports fell from Bs.3484 million in 1948 to 3360 million in 1949, and between 1949 and 1950 treasury reserves declined from Bs. 474 million to 191 millions.

At the bottom of these setbacks was the inability of European countries to buy Venezuelan oil without hard currency and their increased reliance on Middle East petroleum. In 1948 Europe bought 34 per cent of Venezuelan oil; in 1950 only 22 per cent. Venezuela is by now resigned to the eventual loss of many of her former markets in Europe and instead looks hopefully to the expanding demand of the Western Hemisphere.

It remains to be seen, however, whether these New World markets will develop quickly enough to solve Venezuela's problems. One of these is that in 1951 payment for 97.7 per cent of the oil exported was made in dollars although only 55 per cent of oil went to the dollar area. How much longer can and will the non-dollar countries find hard currency with which to buy her oil? Major oil companies are going to great pains to keep down the dollar element in their costs, but there are obvious limits to this in view of the large payments which must be made to the government in bolivars, the policy of buying wherever possible and the necessity for even non-American companies to buy not a little of their specialized equipment from the United States manufacturers.

The U.S.A. must remain Venezuela's crucial market and the latter's awareness of this fact was shown by its sustained efforts to secure new tariff concessions for its oil shipments to America. Venezuela is also apprehensive of the rapid growth of the Canadian petroleum industry next door to the United States, since this would enable the British dominion to carve out a growing slice of the American market for its oil. * * *

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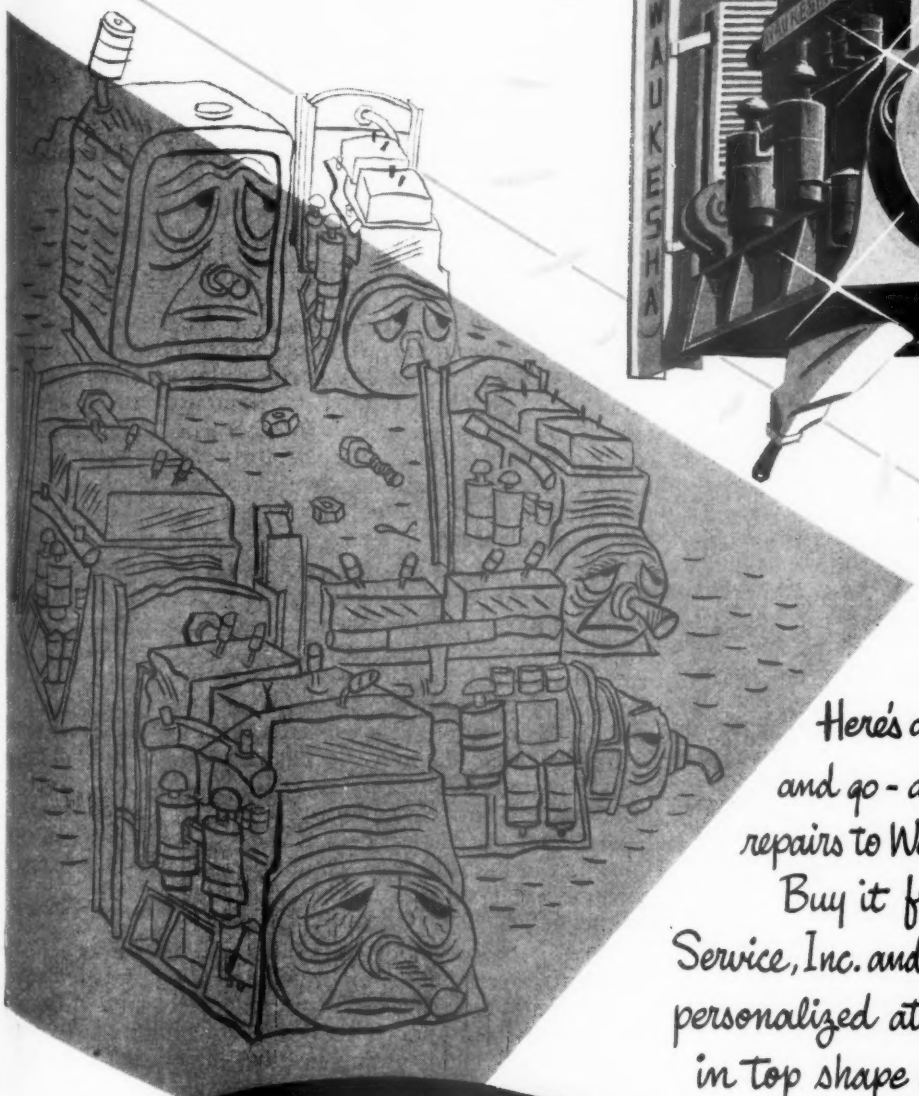

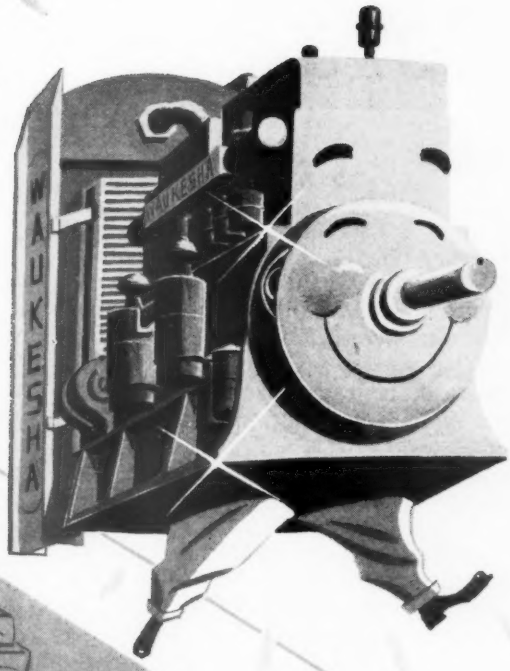

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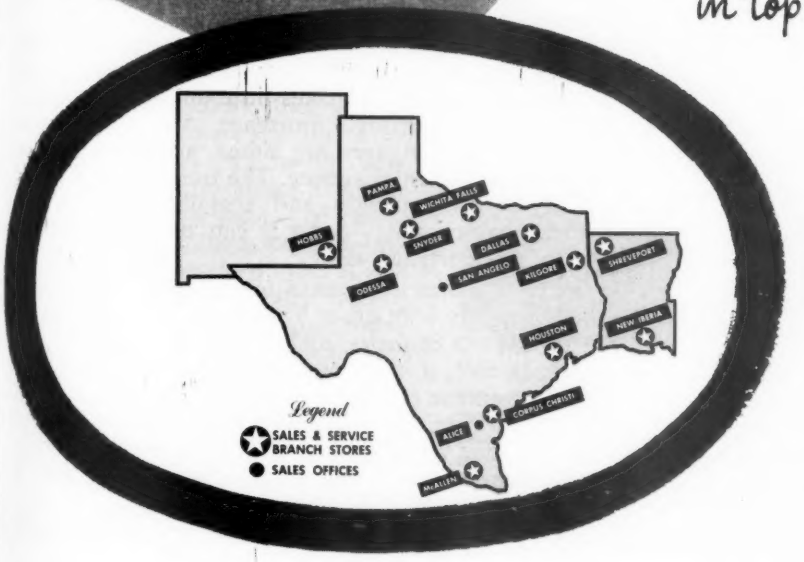

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PUBLIC AND PRIVATE

How Burdensome Is the Debt?

Arthur A. Smith

LAST month a Treasury official attracted comment by stating that the Federal Government's debt now represents a much smaller proportion of all debt in the United States than it did right after World War II. He was trying to minimize the fact that we are facing another Federal deficit next year. Instead, he caused some excited remarks about the size of the total debt, both public and private, in the United States.

The Wall Street Journal, for example, followed soon after with a story which began: "America's debts . . . may be pushing close to a precarious level."

Just how serious *is* the level of debt at this time? In order to answer this question, let's look at the size of the net debt in past years. (Note that this is *net* debt. This is a more significant measure than gross debt, which includes duplications.)

	1929	1933	1939	1945	1953	1954 (est.)
Debt (in billions)						
Public	29.7	41.0	58.9	266.4	256.7	265.5
Private	161.2	127.5	124.3	140.0	328.8	349.0
Total	190.9	168.5	183.2	406.4	585.5	614.5
Gross National Product (in billions)	104.4	56.0	91.1	213.6	364.9	356.0
Total Debt as % of Gross National Product	183%	301%	201%	190%	164%	173%
Public Debt as % of Total Debt	16%	24%	32%	66%	44%	43%

Two things stand out here. One is the change in relative importance of the public debt — the change emphasized by the Treasury official. Possibly more important is the relationship between the total debt and the Gross National Product. The real "burden" of a debt depends on the productivity of the assets behind it, and the Gross National Product is a good measure of the nation's productivity (it is the total value of all goods and services produced in the country).

With this in mind, today's debts do not look quite so frightening. At the end of 1954 they were 173 per cent of Gross National Product, whereas just after the war they were 190 per cent of it—and in the depths of the depression (1933) they were over three times as large as the nation's production.

It is this last ratio which is most significant, for, if we should have another serious recession, our present debt would become a "burden" in every sense of the word. *So long as an increase in indebtedness is accompanied by an increase in the nation's productivity, then we have little to worry about.* It is part of the process of economic growth. But when our debts rise faster than our ability to pay them, it is another story. It is not the *absolute* size of the debt which is most important, but the size of the debt in *relation to our ability to repay it.*

There are two things which could seriously reduce our ability to repay our existing debts: One is a fall in prices, the other is a drop in the physical volume of goods and services produced in the nation.

As for the first of these—a price decline—there does not seem to be much danger of a serious drop in the foreseeable future. Prices have been remarkably stable for over two years. The wholesale price index in December, 1954, was 109.4. Two years earlier it was 109.6. There are many elements in our economy which tend to keep prices from falling very fast (for example, political pressure, wage demands of organized labor, farm parity prices, etc.)

The second possibility—a drop in the Gross National Product—is not quite so improbable. Gross National Product declined about 2½ per cent during 1954. However, all of the signs point to an increase during 1955. Government economists have forecast a potential increase of almost 50 per cent by 1965. If this prediction were fulfilled we could increase our debt by over $25 billion each year from now until 1965 without increasing the relative burden of the debt.

This does not mean, of course, that a large debt should be lightly dismissed. Obviously, the individual or corporation who has borrowed beyond his ability to repay is in a serious predicament. And if, due to a business recession, there should be widespread defaults on debts, this would serve to make the recession more severe. For this reason, some people view our large debt as an element of instability in the economy. In this respect, we must differentiate among different kinds of debts. There has been little concern, for example, over the ability of corporations to repay existing debts. The financial position of most corporations is very good today, and most long-term corporate obligations are gradually being repaid through sinking funds.

Most of those who have expressed concern over the debt have referred to that owed by individuals, particularly in the form of mortgages. The mortgage debt on non-farm, one-to-four-family homes totaled $72.6 billion at the end of September, 1954, an increase of 12 per cent over the previous year.

It should be remembered, however, that in many cases *the individual who signs a mortgage has not increased his total economic burden.* It makes little difference whether he pays rent or amortizes a mortgage. Also a large percentage of these mortgages are either guaranteed or insured by a governmental agency. The trend toward home ownership is economically and socially desirable. It strengthens our economy—and it can be accomplished only through mortgage debt.

In short, the sharp increase in our total debt since World War II has been offset by an even greater increase in our productive capacity, and thus in our ability to repay debt. In fact, if we expect our output of goods and services to continue to increase, we can also anticipate an increase in our debt. *Our problem is to prevent any serious recession.* If one were to occur, our debt would be only one of a great many problems which would confront us.*

This article appeared in the *Economic Letter*, publication of First National Bank in Dallas. Dr. Arthur A. Smith, the editor, is vice president and economist for the bank.

General Counsel for Ashland & Allied.

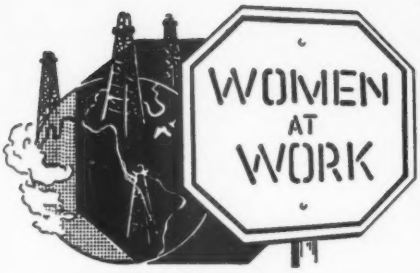
Lawyer Is Oil Company Officer

Lois Mae Smith joined Allied Oil Company, Inc., as assistant office counsel in 1943 at Cleveland, Ohio. Her duties were to keep Allied and its seven wholly owned subsidiaries in compliance with administrative regulations issued by government agencies on operations, wage and salary controls, priorities and allocations of critical materials, selective service, price and rationing, etc. She was just the girl to handle the job; she took it after 18 months with OPA Cleveland Regional office where she headed ration banking for the area.

By the time government regulations were revoked, Miss Smith's duties had branched out into the administrative end of the business where she handled the insurance program—fire and theft, comprehensive public liability, marine, cargo, inventory, casualty, workmen's compensation and unemployment compensation in the 12 states where Allied operated.

In 1948 Allied was purchased by Ashland Oil & Refining Company. Miss Smith continued as general counsel for the Allied and Ashland companies and divisions operating out of the Cleveland office. In 1950 she was named assistant secretary of Cleveland Tankers, Inc., Allied-Ashland Tankers, Inc., and all the Allied companies. Her duties include all matters of a legal nature, contracts, insurance, taxation, and nine separate union contracts, and health and welfare trust funds covering operations in the Cleveland area, as well as compliance with NLRA, FLSA, Walsh-Healey Act, Robinson-Patman Act, in addition to numerous state laws that affect company operations.

Miss Smith received her A.B. degree *cum laude* from Notre Dame College, and her LL.B. from Cleveland-Marshall Law School. She specialized in taxation, banking and finance, and admiralty law at Western Reserve University Graduate School, was admitted to the Ohio State Bar in 1943 and to practice before the United States Tax Court in 1952.



She lives at 12701 Shaker Blvd. in Cleveland, is active in the Cleveland Bar Association, Ohio State Bar Association, Women Lawyers Club of Cleveland, National Association of Women Lawyers, Zonta International, Phi Delta Delta legal fraternity, Desk and Derrick Club of Cleveland, the Cleveland Skating Club and the Acacia Country Club. She golfs, plays tennis and ice skates—"for recreation only."

Expert in Refining Business

Irma Trout joined Standard Oil Company (Indiana) on June 3, 1926, at Greybull, Wyoming, where she became a car record and billing clerk in the shipping department of the refinery. Since that time she has worked in the yield and storehouse departments and the shipping office. In the latter two positions she headed the department.

In 1949, when the Greybull refinery was closed by Standard of Indiana, Mrs. Trout moved to the company's Casper refinery where she became cashier, which position she held until June 1954, when she was promoted to confidential and specialized accountant in charge of salaried payrolls.

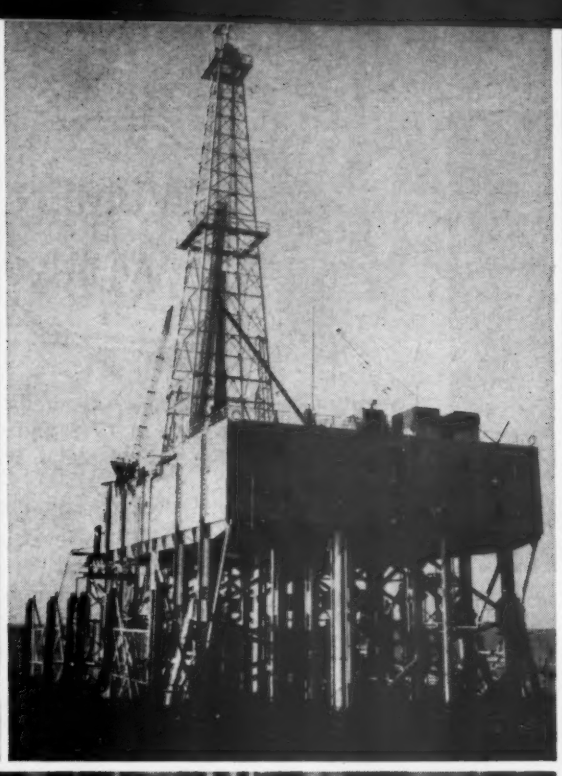
L. W. Houghton, office manager, says: "Her duties involve the payment of salaries of supervisory and clerical personnel, and the many reports pertinent to such work. In addition, because of her ability and knowledge of refinery accounting procedures, she is often asked to compile special reports for management. She is extremely capable and efficient and we consider her a valued employee."

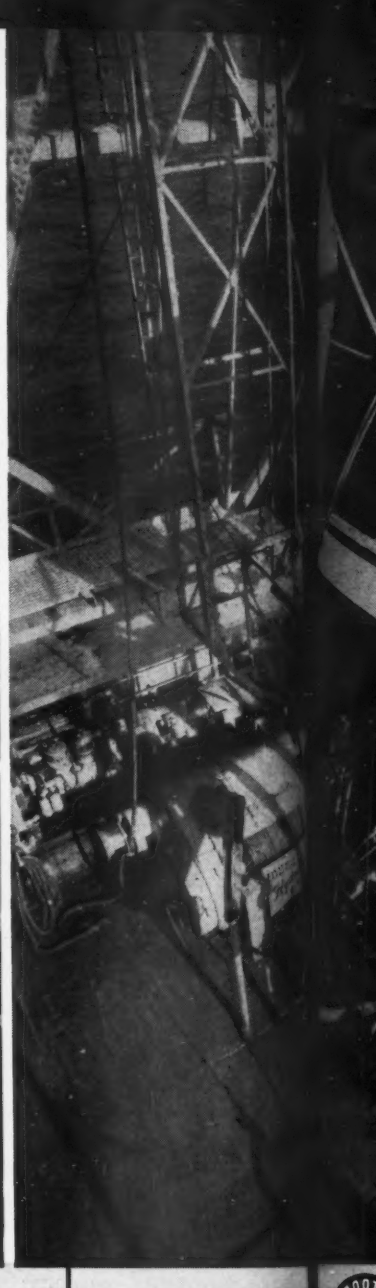
Irma Trout heads confidential accounts.

A native of North Dakota, where she attended school and held her first job, Irma was stenographer in a law office, a newspaper woman and a housewife before she became an oil employee. She and her husband, who is a diesel locomotive engineer, own their own home in Casper.

She claims she hasn't time for outside activities, but adds: "Of course I read a lot, am active in the Desk and Derrick Club and attended the national convention at Banff, sing in St. Anthony's choir, garden, and do church work—but these are just part of my life —not extracurricular activities!"

WOMEN AT WORK · · · Officers and directors of Desk and Derrick Clubs meet at Tulsa, Oklahoma, to draft plans for the organization's fourth annual convention. The meeting, scheduled for September 2 and 3 in New York, is expected to attract 2000 members from the club's 99 local chapters throughout the United States and Canada. Board members shown are: Seated, Eloise Limbocker, The Texas Company, Port Neches, Texas; Frankie Frensley, W. P. Luse Company, Dallas; Edna Hurry, Jersey Standard, New York City; Nelle Barclay, Fain-Porter Drilling Company, Oklahoma City; Sybil Sureck, Union Oil of Oklahoma, Oklahoma City; Irene Stimson Cox, Panhandle Producing, San Antonio; Bettie Conley, Estate of William Helis, New Orleans. Standing: Pauline Colahan, Monterey Oil, Bakersfield, California; Catherine Connell, Texas Company, Chicago; Leta Dillon, Deep Rock, Tulsa; Minetta Miller, Ernest S. Baker, Denver; Irma Cline, Nelson, Montgomery, Robertson & Sellers, Wichita Falls; Edna Resky, Pacific Petroleums, Calgary, Canada; and Angela Cross, Plymouth Oil, Pittsburgh.





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BOOKS ★

The Vertical Pump by Johnston, *edited and published by Johnston Pump Company, 3272 East Foothill Boulevard, Pasadena, California. Pages, 392. Price, $10.00.*

A most complete and authoritative reference book on the vertical turbine pump has just been issued by Johnston Pump Company. This manual discusses pump selection for hot, volatile, viscous and corrosive fluids, applications, engineering formulas and data. The development of ground water resources, geology, drilling methods, well logging, construction, design and performance characteristics of vertical turbine, mixed flow and propeller pumps, and many other factors are analyzed.

Specific papers have been contributed to the book by many leading world authorities, including E. W. Bennison, engineer of Edward E. Johnson Company, Inc.; R. R. Smith, F. M. Smith and A. H. Miller of Durametallic Corporation; C. W. Joseph, Chemstrand, Inc.; Herbery Goyod of Well Instrument Developing Company; and experts from the University of California, Department of Agriculture and many others.

This carefully indexed "bible" of the vertical pump industry in one volume furnishes a foundation upon which the engineer, regardless of his field, may base his premise and evaluate his individual pumping problem. Basic design principles and operating characteristics are outlined and examples given to show their practical applications.

Modern Petroleum Technology, *edited by E. B. Evans, The Institute of Petroleum, 26 Portland Place, London, England. Pages, 702.*

This volume covers the oil industry from exploration and drilling and follows it through the complete phase, including refining, distribution and marketing, and includes a symposium of the economic aspects of the petroleum industry.

This follows an edition put out by the Institute of Petroleum in 1946, and is patterned in the same general style. Many of the same articles have been revised or rewritten from the old, while some are completely new.

Although the scope is so large, the editors have well preserved the technical and scientific background necessary to make this book of significance. A score of writers have combined their efforts in the authorship of articles best suited to their individual realms of the old world.

Pipe and Tube Bending, *Paul B. Schubert, published by The Industrial Press New York, New York. Price, $5. Pages, 183.*

A long-felt need for a practical working manual that describes and illustrates common methods of bending both ferrous and non-ferrous pipe and tubing is answered with publication of this book. In addition to useful data and pointers for both shop and field men, the book describes the machines, fixtures, and devices needed and used. An entire chapter is devoted to pipe layout for bands and gives formulas used for various degrees of bend and data on minimum radii for bends. Illustrations and diagrams are plentiful, and 15 helpful tables add to the book's value.

Fundamentals of Electric Log Interpretation, *by M. R. J. Wyllie, Published by Academic Press, Inc., 125 East 23rd Street, New York 10, New York. Pages, 126. Price, $3.60.*

Designed to explain in the simplest possible terms the underlying principals of electric log interpretation, this excellent manual is prepared for the non-specialist worker to assist him in an appreciation of the technique of this interpretation. It does not duplicate the previously published charts, curves, and tables issued as aids in detailed log evaluations but does list the more important of these publications and attempts to explain their application. It also lists and discusses some of the advantages and disadvantages of the different logging instruments and techniques that are presently available for oil field use.

Offshore Summary, *Emory N. Kemler and Edward W. Rosencrants, published by Summary Reports, P.O. Box 176, Spring Park, Minnesota. Price $20.*

While basically a summary of patent information relative to offshore operations and including a large number of patent abstracts, this volume also discusses in considerable detail work done in the investigation of wind and wave predictions and wave force. In addition, chapters describing offshore structures and other methods of marine exploration, offshore pipe lines, and operating practices are presented. An extensive bibliography of the subject is also carried.

Professional Engineering Registration Laws, *compiled by Alfred L. McCauley, Trustee Publication Fund, Jefferson City, Missouri. Pages, 614. Price, $8.75.*

In the United States, there are 38 legally recognized and regulated professions. There are more than 1100 registration laws, administered by licensing boards having some 7500 members. The professional engineer is one of 13 that are licensed in all 48 states. The laws in these states vary in age, rigidity, and number from state to state. It is to acquaint the engineer or engineer-prospect, with these laws that this book has been published.

This compendium of engineering registration laws has been compiled and edited by McCawley under the sponsorship of the National Society of Professional Engineers. As far as is known, it is the only compilation of such laws for the United States and its possessions. It lists the exact legal requirements that must be met for professional practice, the legislative authority for the law involved, the educational requirements, the years of experience required, examinations, fees and bond, engineer-in-training laws, certificate applications, temporary permits, etc., listing them by the individual state.

Oil Slanguage, Jerry Robertson, *published by Petroleum Publishers, Evansville 8, Indiana. Pages, 181. Price, $3.65.*

Jerry Robertson, who has been writing about oil since 1938, has followed his excellent book, "ABC's of Oil" with "Oil Slanguage," which is an alphabetical listing of oil field slang and terms which have developed in the oil industry. Since occasionally these terms differ in different areas, Jerry gets around that by putting in everything from just about every area. There is the slang, the abbreviations, like "b/d" and such mathematical terms as "decline curve." There are, in addition, scattered throughout, cartoons and bits of information, such as "last year nearly 900 new previously untapped oil pools were discovered in the U.S., more than enough to name one after every city in the country with a population over 15,000."

The listing of oil field terms is followed by a generous supply of "Done in Oil" stories.

Jerry is a thoroughly experienced oil field worker. He covered oil booms from Ranger, Texas, to Rangely, Colorado. For the past 15 years with his wife, Mitty, he has owned and published the *Tri-State Oil Reporter*, which covers activities in oil producing counties around Evansville, Indiana.

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LAUGH with BARNEY

A complacent golfer teed his ball, looked away to the next green and declared confidently, "That's good for one long drive and a putt."

He swung the driver, tore up the sod and managed to move the ball a few feet off the tee.

Stepping forward, the diplomatic caddie handed him the putter and suggested, "Now for one heck of a putt."

Mrs. Jones answered a very faint knock on her front door. A little fellow about six was standing there. "Please, Mrs. Jones, could I have my arrow?" he asked.

"Certainly," replied a somewhat bewildered Mrs. Jones. "Where is it?"

"I think it's stuck in your cat.'

Hillbilly to neighbor: They tell me your wife makes moonshine whiskey.

Neighbor: Yes, and I'm asnamed of her, but with all her faults I love her still.

"Did you miss your train, Sir?"

"No, I didn't like its looks, so I chased it out of the station."

A lady on a Chicago bus took the only empty seat—next to a harmless-looking little drunk—and opened a map. It was, a friend of ours discovered by craning his neck a bit, a detailed map of Manchuria. The drunk studied the map for a time, too, and finally addressed the lady in diffident tones. "Sure you're on the right bus?" he asked.

Tim: What was the cause of the collision at the corner today?

Jim: Two motorists after the same pedestrian.

Boss (pointing to cigarette butt on floor): Jones, is this yours?

Jones (pleasantly): Not at all, sir. You saw it first.

"Do you have any physical defects?" the army doctor asked.

"Yes, sir!" the draftee answered promptly. "No guts."

The young college freshman wrote home to his Dad as follows:

"Dear Dad: I've decided to quit school and get married. I'm engaged to a peach."

In due course, he received the following reply:

"Dear Son: Suggest it would be wise to take my advice, and leave the peach on it's parents stem, until you are able to preserve it."

"What makes you think your wife is getting tired of you?"

"Every day this week she's wrapped my lunch in a road map."

"Say, I hear you lost your job. Did the foreman fire you?"

"Well, you know what a foreman is—he's the guy that stands around and watches the other fellows work."

"What's that got to do with it?"

"Why, he got jealous of me. People thought I was foreman."

In an English political meeting one of the candidates patriotically orated: "I was born an Englisnman. I have lived an Englishman. I nope I shall die as an Englisnman."

From the back of the hall, in an unmistakable accent, came the question, "Mon, hae ye no ambeetion?"

"Talk about Napoleon being a strategist! Why he didn't hold a candle to that bird Simpson, in our office!"

"Why? What do you mean?"

"Got his salary raised six months ago, and his wife hasn't found out about it yet!"

A boy and his mother stood looking at a dentist's showcase.

"If I had to have false teeth, mother, I'd take that pair," said the small boy, pointing.

"Hush, James," interposed the mother quickly, shaking his arm. "Haven't I told you it's bad manners to pick your teeth in public?"

He: I'm a self-made man.

She: Well, you're certainly big about it. Lots of men would blame somebody else.

It is better to sit in the back row and be discovered than to sit in the front row and be found out.

She was young and fair and pretty
She's a girl I'll ne'er forget,
We were in a Pullman sleeper,
When by accident we met.
Yes, I always shall remember well,
The girl, the time, the place;
I was coming from the upper berth
And I stepped upon her face.

A psychiatrist says women like girdles because of a natural desire to be squeezed.

Lawyer (to his witness): Are you acquainted with any of the jury?

Witness: Yes sir, more than half of them.

Lawyer: Are you willing to swear that you know more than half of them?

Witness: If it comes to that, I am willing to swear that I know more than all of them put together.

A second-grade teacher, reviewing the year's work, inquired of her pupils: "Who can tell us where the home of the swallow is?"

After some hesitation, a pudgy youngster held up his hand. "I think," he asserted, "that the home of the swallow is in the stommick."

Driver of Austin: Please give me a glass of water for the radiator and a thimble of oil for the motor and a half pint of gasoline.

Attendant: Sure you don't want me to cough in your tires?

Jane: Alice, where did you get that fur coat?

Alice: Just a piece of good luck; George fell and broke his leg and the insurance company sent us the money.

Two women chattered pleasantly as they started off shopping one day. "That neighbor of yours," said one, "she's a bit of a gossip, isn't she?"

"I don't like to say," replied the other, "but when she came home from her summer's vacation, her tongue was sunburned."

Several old timers were sitting around at the little general store at the crossroads in a rural Western community recently and the discussion was about Indians and the early days of the Old West.

"I'll never forget the time I killed my first Indian," remembered one old frontiersman.

"Did you shoot him?" asked a visitor from the East.

"Nope," replied the old man.

"Then you must have killed him in a hand-to-hand fight with your knife," concluded the visitor.

"Nope, son, nothing like that," was the reply. "I ran him to death—yep, I ran him to death—with me in front."

The old colonel, visiting a friend in the North, was waxing eloquent under the glow of his iced glass.

"In our sublime land, suh" he told his host, "a gentleman is not obliged to toil. The true gentleman's plowin,' sowin,' an' reapin' is done by hired hands—an' his sellin' is done by the sheriff."

City Visitor: Which is correct, "a hen is sitting or a hen is setting?"

Farmer: I dunno and don't care. All I bother about is when she cackles is she "laying or lying?"

An English lady, self-appointed supervisor of village morals, accused a workman of having reverted to drink because "with her own eyes" she had seen his wheelbarrow outside a public house. The accused made no defense, but that evening placed his wheelbarrow outside her door and left it there all night.

An inscription over one of the Government buildings in Washington consists of the well-known phrase: "What is Past Is Prologue." A sightseer asked his taxi driver for an explanation of the meaning of the phrase.

The taxi driver said, "That's only Government talk for 'You ain't seen nothin' yet'."

Good resolutions are like babies crying in a theater. They should be carried out immediately.

After months of effort, the old merchant at the general store finally collected from a stubborn debtor.

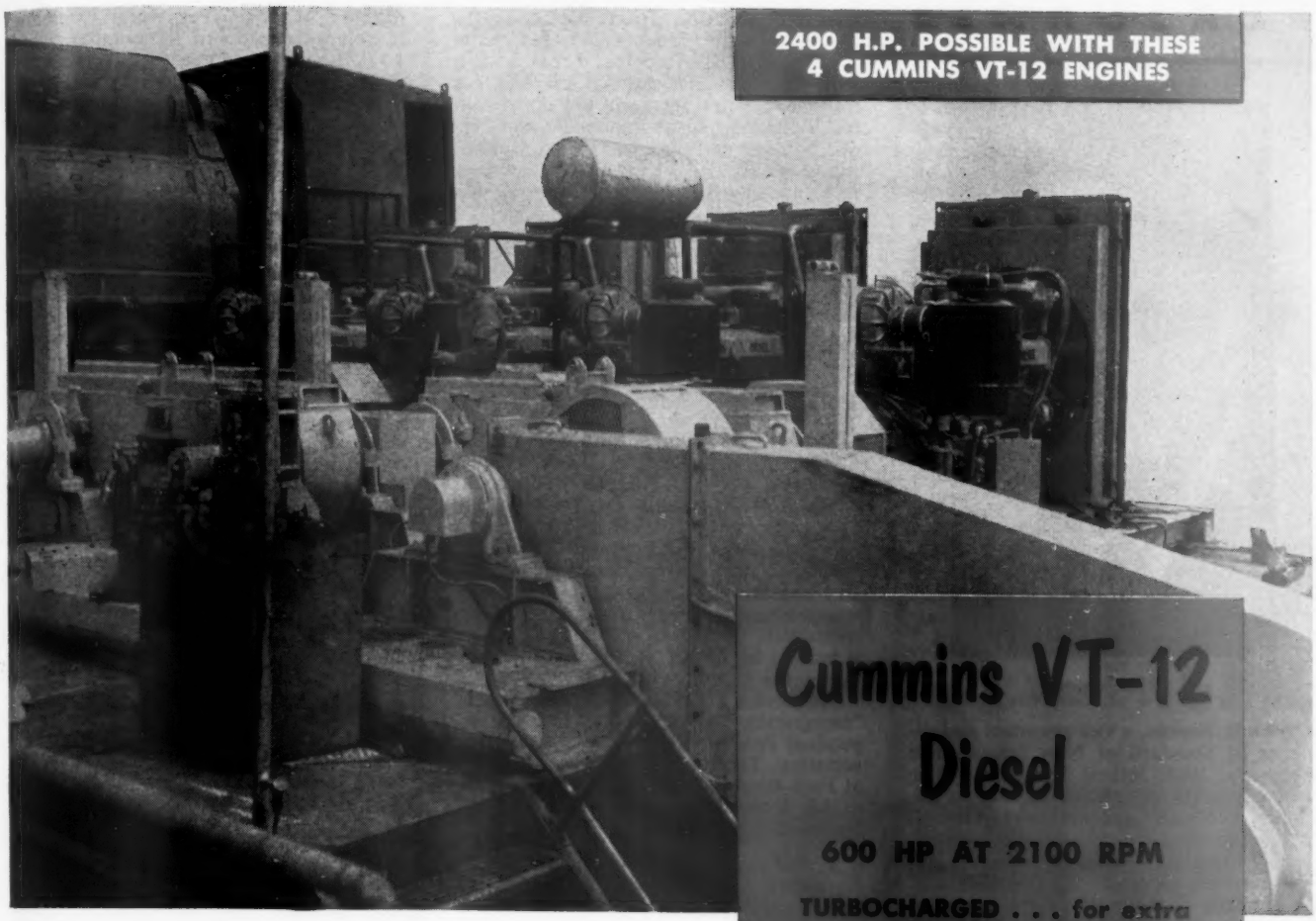
"Say on my receipt," said the ornery ex-customer, "that I don't owe you a thing."

With painstaking care, the old storeman wrote, "Bearer don't owe the undersigned nothing—and ain't going to."

There's something feminine about a tree. It does a strip tease in the fall, goes with bare limbs all winter, gets a new outfit every spring and lives off the saps all summer.

Husband: Maybe we can figure out what the problem is.

Wife: I already know what the problem is. It's having too much month left over at the end of the money.



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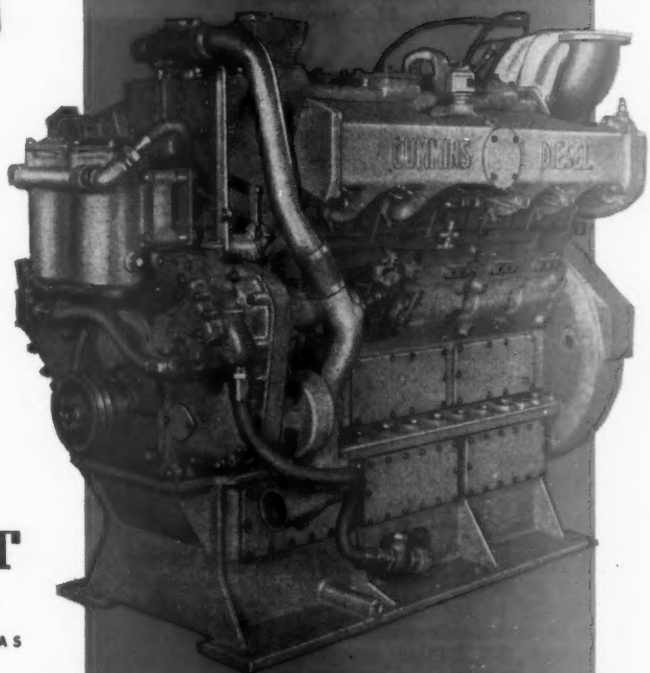

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John R. Suman, a vice president and director of Standard of New Jersey since February, 1945, retired March 31, after 44 years in the petroleum industry as engineer, geologist, and executive. One of the nation's most widely known oil men, Suman has been a prime mover in oil and gas projects, especially in initiating and developing conservation practices. In 1943, the American Institute of Mining and Metallurgical Engineers awarded him the Anthony F. Lucas Medal for "distinguished achievement in improving the technique and practice of producing petroleum."

W. R. Huber, Gulf, was elected 1955 chairman of the Oil Industry Information Committee of the American Petroleum Institute. Vice Chairmen are **L. R. Kamperman,** Leonard Refineries; **Kerryn King,** The Texas Company; **Richard Rollins,** Atlantic Refining; **Roy M. Stephens,** Humble.

The chairman of The British Petroleum Company, **Sir William Fraser,** on whom a Barony was conferred in Britain's New Year Honor's List, has chosen the title of Lord Strathalmond of Pumpherston. His title recalls his connection with the Scottish shale oil industry. The River Almond flows through the Scottish shale fields and "Strath" is a Gaelic derivative meaning "valley."

James W. Hennet has been named export advertising supervisor for the eastern division of Tide Water Associated Oil Company. Hennet joined the company in 1947.

Rahmatollah Ghavami has been appointed a member of the board of directors of Iranian Oil Exploration & Producing Company. **Mahmood A. Poozeshi** has been appointed a member of the board of directors of the Iranian Oil Refining Co. N.V. These appointments bring the number of members of the board of each company to the full complement of seven, in accordance with the agreement between the Iranian government, The National Iranian Oil Company and the Consortium members.

Kirk Jordan has been appointed district representative from Wichita Falls, Texas, for the Independent Petroleum Association of America. Jordan, who will represent the national oil and gas trade association in north and north central Texas, the Texas Panhandle, the Permian Basin and southern New Mexico, succeeded **B. H. Vickrey,** who recently was named membership director for IPAA.

D. C. Norwood has been reelected president of the North Texas Oil and Gas Association. **Wayne O. Watts** is first vice president, succeeding **Charles N. Prothro,** and **Ralph O. Harvey,** second vice president, succeeded Watts. **George W. Anderson, Jr.,** is executive vice president.

Walter S. Hallanan, president of the Plymouth Oil Company was reelected chairman of the National Petroleum Council. **R. G. Follis,** chairman of the Board, Standard Oil of California, San Francisco, was reelected vice-chairman. **James V. Brown** was reappointed secretary-treasurer. **A. Jacobsen,** Amerada, was reelected chairman of the Agenda committee. The Appointment committee is headed by **Frank M. Porter,** American Petroleum Institute.

Hallanan also received the annual "recognition award" of the Texas Independent Producers & Royalty Owners Association. The award, given at a banquet at Fort Worth, Texas, was in recognition of his long service as chairman of the National Petroleum Council.

T. J. Fuson, Humble Oil and Refining Company, has been elected chairman of the southwest production district of API.

API citations for outstanding service were awarded to five by the Southwestern district, division of production. **Paul L. Deverter,** Humble, was cited for measurement of natural gasoline; **H. M. Harris,** who has retired from Humble, for standardization of oil field equipment; **Drew Young,** Atlantic Refining, supervision development programs; **Floyd E. Hatfield,** Gulf, API district activities, and **S. C. Oliphant,** Tennessee Gas, drilling and production practices.

J. B. Cook has been elected vice president of Woodley Petroleum Company. Secretary-treasurer of the company since 1944, he will continue to serve as treasurer in addition to becoming vice president in charge of finance. He is also vice president and treasurer of Woodley Canadian Oil Company and a member of the board of directors of Great Northern Oil Company and Minnesota Pipe Line Company.

E. David Philley was elected to serve as secretary of Woodley. Philley joined the company in December, 1953, as manager of the land department.

J. W. Boothe was elected assistant treasurer of the company. Boothe has served as chief accountant since 1943 and as assistant secretary since 1948.

Canadian Oil Companies, Limited, has appointed **Wallace M. Luthy** as manager of production, a newly created position. He has been associated with crude oil production and supply for the past 20 years.

1955 President of the Los Angeles Chapter of Nomads, H. J. Schlarb of Chiksan Company, left, receiving the chapter gavel from John F. Flanagan, Johnston Testers, Inc., retiring president, at the sixteenth annual Inaugural Ball.

New officers and regents of Los Angeles Chapter of Nomads: James D. Hughes, Lane-Wells, senior regent; John F. Flanagan, Johnston Testers, Inc., junior regent; H. J. Schlarb, Chiksan Company, president; Harry E. Hester, McCullough Tool, vice president; Earle R. Atkins, Emsco, secretary; Leo Cypher, Baash-Ross, treasurer; Robert P. Gaylord, Wagner-Morehouse, sergeant-at-arms; Harry Taylor, Bettis Rubber, assistant treasurer; Knight Templeton, S. R. Bowen Company, assistant secretary; W. A. Wilson of Web Wilson Oil Tools, master of ceremonies. H. Rex Collins, Jr., Hydril Company, deputy sergeant-at-arms, was absent in Venezuela.

F. O. Prior

A. W. Peake

▸ **A. W. Peake,** president of Standard of Indiana since 1945, and a director for 25 of the 34 years he has served the company, will retire as president May 3. **Frank O. Prior,** executive vice president since 1951 and a director for the past 10 years, has been elected to succeed him as president effective on that date. Peake will retain his Standard Oil directorship until May 5, date of the company's annual meeting. His seat will not be filled, and the number of directors will be reduced to 15 as of that date.

W. B. Emery

P. L. Henderson

▸ **W. B. Emery,** a director and vice president of production, has retired from The Ohio Company after completing 36 years of service. **Paul L. Henderson,** chief geologist, has been elected to succeed Dr. Emery as a member of the board of directors and vice president of production for Ohio Oil.

▸ **B. W. Pickard** has been appointed president of California Oil Company. He succeeded **E. W. Endter** who resigned March 7. Pickard who has had 33 years' experience in petroleum marketing, was formerly assistant general sales manager.

▸ **Marvin H. Watts** has been reelected president and general manager of Rocket Oil and Gas Company, Tulsa, Oklahoma.

IDEA!

The oil industry continues to stay on the defensive as one state after another raises gasoline taxes and the Federal government holds the 2 cents a gallon tax.

Instead of asking for mercy, why not a more intense offensive by oil companies to have gasoline and lubricant sales taxes spent for highways only? A good portion of oil products taxes are spent for other purposes. Right now direct and indirect taxes on gasoline are more than its actual cost.

If the 2-cent Federal tax were relinquished in favor of states, there would be less money spent for administration.

H. G. Fillhower

R. C. McCurdy

▸ **Howard G. Fillhower** has been appointed manager of the employee relations department, Tide Water Associated Oil Company, with headquarters in San Francisco, California. He will be responsible for planning, developing, and coordinating the national employee relations activities of the company.

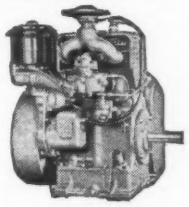
▸ **R. C. McCurdy,** president of Shell Chemical Corporation, has been elected to the board of directors of Shell Oil Company. A Stanford University graduate, he has been president of Shell's chemical company since 1953.

▸ **Colin C. Rae** has retired from active work as assistant to the president of Skelly Oil Company. He has been engaged for 42 years as geologist, petroleum engineer, and executive for various oil companies.

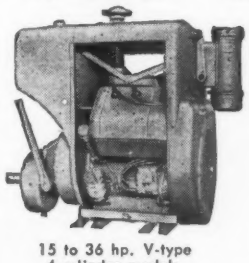
▸ **R. A. Wilson** has been named Eastern district superintendent of operations in Illinois, Indiana and Pennsylvania for Tide Water Associated Oil Company.

Vital Oil Circulating Pump powered by WISCONSIN HEAVY-DUTY *Air-Cooled* ENGINE

3 to 9 hp. single-cylinder models.



7 to 15 hp. 2-cylinder models.



15 to 36 hp. V-type 4-cylinder models.

Down at a field in Stephens County, Oklahoma, this oil circulating pump works, hour after hour, day after day. It's powered by a Wisconsin Heavy-Duty Air-Cooled Engine, best choice when you need an engine that's built to deliver continuous heavy-duty service.

And in the oil fields the story is the same wherever equipment reputation is built by reliability. Oil men know that Wisconsin Engines go on delivering dependability day after day, month after month. The reasons for this kind of service are many. Such features as tapered roller bearings at both ends of the crankshaft, and fool-proof air-cooling in all temperatures are very important performance factors. Also contributing to no-complaint operation is a trouble-free ignition system with an easily-serviced OUTSIDE magneto, along with heavy-duty construction even in those parts not vital to dependable service. No wonder, when you need power that *ranks first*, your *first choice* should automatically be Wisconsin Engines.

Power TO FIT THE JOB

Power TO FIT THE MACHINE

4-cycle single-cylinder, 2-cylinder and V-type 4-cylinder models, 3 to 36 hp.

WISCONSIN MOTOR Corporation
MILWAUKEE 46, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

WRITE TO HARLEY SALES CO.
619 SOUTH MAIN STREET • TULSA, OKLAHOMA
3420 McKINNEY AVENUE • HOUSTON, TEXAS
505 SOUTH MAIN STREET • WICHITA, KANSAS
OIL FIELD DISTRIBUTORS FOR WISCONSIN ENGINES AND ALL TYPES OF UTILITY UNITS

Amazing NEW Oakite

RUSTRIPPER

...Slashes tower down-time by more than 25%!

Texas refinery saves $1200 in ONE Cleaning Operation

Refiners everywhere are finding more and more uses for revolutionary Oakite RUSTRIPPER. This remarkable NEW alkaline material simplifies practically every cleaning job...reduces costs, too. Here's how amazing Oakite RUSTRIPPER saved one Texas refiner $1200 in a *single* cleaning operation:

The problem was to recondition a 28-tray, 5 man-way oil absorber tower containing 2304 four-inch bubble caps. Last cleaning had taken 24 hours—an extremely expensive proposition, since every hour of down-time costs this refinery $100! The superintendent agreed to give Oakite RUSTRIPPER a try.

After rinsing the tower with steam and hot water for two hours, a pre-mixed solution of Oakite RUSTRIPPER was pumped into the unit from a 1000-gallon tank mounted on skids nearby. The solution was recirculated and agitated for ten hours at 210°, then routed through the mist extracter for an additional three hours, and drained out. A three-hour circulating water rinse completed the cleaning cycle.

Results? Oakite RUSTRIPPER had not only accomplished a cleaning job that was 95% perfect, but had reduced down-time by *six* hours, slashed cleaning costs by *$1200!*

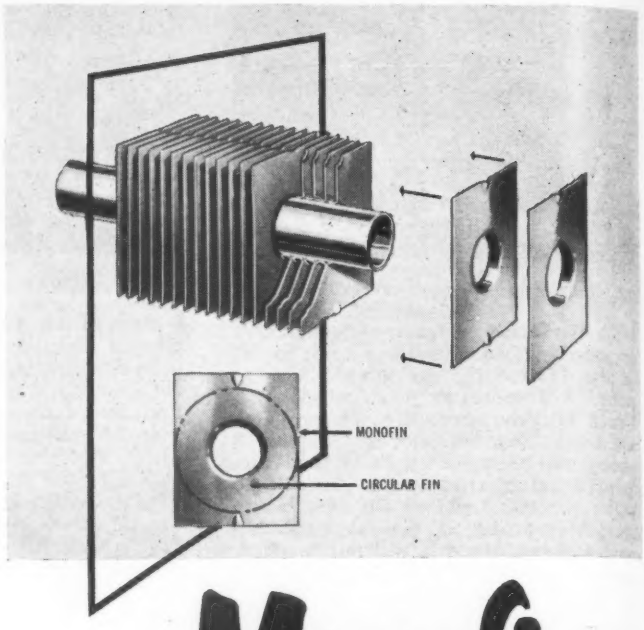
Oakite RUSTRIPPER is also excellent for reconditioning salvaged parts, stripping paint from metal equipment, and many other heavy-duty refinery conditioning chores. RUSTRIPPER is safe, too...won't attack sound metal or give off troublesome fumes. Your local Oakite Technical Service Representative will gladly demonstrate remarkable Oakite RUSTRIPPER for you at your convenience. Call him today...no obligation. Or write Oakite Products, Inc., 48 Rector St., N. Y. 6, N. Y.

SPECIALIZED INDUSTRIAL CLEANING

OAKITE

MATERIALS • METHODS • SERVICE

Technical Service Representatives in Principal Cities of U. S. and Canada



Monofin

New Young core provides seven times more heat transfer surface

Monofin Core, the most modern development in extended heat transfer, with seven fins per inch provides 58 per cent more extended surface. It also furnishes 7 times more heat transfer surface between tube and fin than a circular fin core with edge contact.

Young Radiator Company *Monofin* finned tubing is available with aluminum or copper fins, with various fin spacings for special applications. Tubing materials are copper, brass, steel or aluminum. Outside tube dimensions are ½", ⅝", ¾" and 1".

Monofin design features perfect mechanical tube to fin bond. It offers less resistance to air flow and more contact area between tube and fin. There is no solder bond to tube to hinder heat flow.

For further details, write for free bulletin to Young Radiator Company, Dept. 215-D, Racine, Wisconsin.

WRITE FOR FREE BULLETIN

Monofin is a Young Radiator Company trademark.

Young RADIATOR COMPANY

RACINE, WISCONSIN

Creative HEAT TRANSFER ENGINEERS FOR INDUSTRY

Heat Transfer Products for Automotive, Aviation and Industrial Applications. Heating, Cooling, Air Conditioning Products for Home and Industry.

Executive Office: Racine, Wisconsin, Plants at Racine, Wisconsin, Mattoon, Illinois

Miss Dorothy Pierce, center, is shown receiving the first Oklahoma City Desk and Derrick Club Bee Woods Davidson Memorial scholarship award of $100 from Miss Mary Clock, left, chairman of the scholarship committee, and Mrs. Lillian Wright, co-chairman. Miss Pierce is a senior geology student at the University of Oklahoma.

B. V. Richardson, Winnipeg, was elected chairman of the board of directors of Fargo Oils, Ltd., Vancouver, B.C. **R. M. Swensnick,** vice president, General American Oil Company of Texas, Dallas, was elected executive vice president and a director.

John E. Arens, formerly head of the economics and financial research department of Union Oil Company of California, has announced the establishment of a new corporate financial consulting business in Los Angeles, California, with offices in the Quinby Building, 650 South Grand Avenue. Arens resigned from his position with the Union Oil Company after 15 years in the petroleum industry.

James H. Durbin, executive vice president, American Republics Corporation, has been elected a director of Barber Oil Corporation.

Mrs. Josephine Hancock has been named president of Travelers Oil Company. She was formerly treasurer of the firm.

Charles F. Hunkins has been appointed manager of geology and engineering of the Oil Development department, Northern Pacific Railway Company. A University of California graduate, he was district superintendent for an independent producing company prior to joining Northern Pacific as chief engineer in 1952.

Gerald C. Summers, senior research technologist at Magnolia's Field Research Laboratories in Dallas, Texas, was awarded a United States Letters Patent for the company in Washington, D. C. Summers was presented with the patent by **Robert C. Watson,** U. S. Commissioner of Patents, for his work on the development of an acoustic velocity logging tool. The award was made in conjunction with the current Patent Office exhibit in Washington on "Research and Technological Progress Under the American Patent System." Summers joined Magnolia in January, 1947.

Albert E. Weightman has been named general manager of Tide Water Associated Oil Company of Canada, Ltd.

Joseph A. Conway, Gulf Oil Corporation's district manager at Norfolk, Virginia, has been appointed district manager for Virginia with headquarters at Richmond.

L. E. Alfred, Mississippi division manager for Arkansas Fuel Oil Corporation, has received a gold award for outstanding work in the American Petroleum Institute's public relations program as a member of the Gulf-Southwest Oil Industries Information committee. Silver awards were presented to **H. S. Flournoy,** Pan-Am Southern Corporation, and **H. X. Russ,** The Texas Company.

Kenneth Newton, a 1946 graduate of Southern Methodist University, has been named chief geologist for Plymouth Oil Company at Midland, Texas. Newton has been geologist for Statex Petroleum at Midland for the last four years and before that was with Sun Oil Company.

ARMSTRONG BROS.
Better PIPE TOOLS

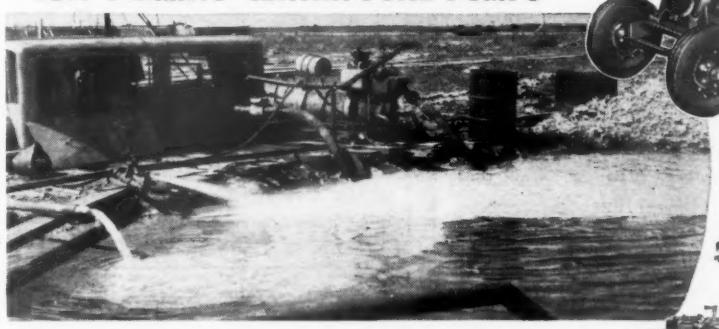
CHAIN TONGS

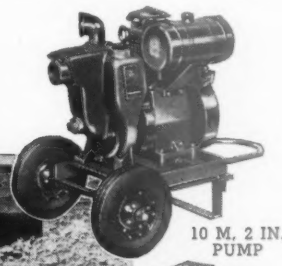
"Reversible," "Standard" and "Ideal" types in all sizes. Jaws are drop forged from special steel, are carefully milled, heat treated, hardened and tested. The *Handles* are forged spring steel. The *Chains* are proof-tested to ⅔ catalog strength (1,200 lb. to 40,000 lb.). 'Reversible" Jaws give double jaw life. "Standard" Jaws have extra bearing on the handle and forged-in chain guides. The "Ideal" Tongs have V shaped teeth for a sure grip on irregular shapes — fittings, etc.

Write for Catalog

ARMSTRONG BROS. TOOL CO.
"The Tool Holder People"
5231 W. ARMSTRONG AVENUE • CHICAGO 30, ILL.

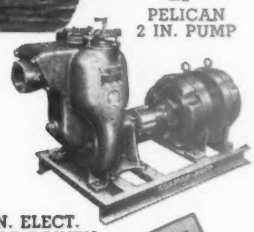
you can RELY ON-
GORMAN-RUPP
SELF-PRIMING CENTRIFUGAL PUMPS





10 M, 2 IN. PUMP

PELICAN 2 IN. PUMP



4 IN. ELECT. MOTOR DRIVEN PUMP

FOR MORE TROUBLE-FREE USE WITH LESS FUEL AND LESS MAINTENANCE

These pumps are built for hard use. Three months continuous runs without shutdowns are not uncommon.

Gorman-Rupp Pumps are the Quickest Priming, Highest Priming, Fastest Pumping and Most Reliable pumps available.

A COMPLETE LINE OF CENTRIFUGAL PUMPS IS AVAILABLE FROM ¾", 1000 G.P.H. UP TO 10", 240,000 G.P.H. CAPACITY.

Mid-Continent and Gulf Coast Oilfield Representative
HENRY H. PARIS DISTRIBUTOR, INC.
1125 ROTHWELL STREET, HOUSTON, TEXAS

THE GORMAN-RUPP COMPANY
MANSFIELD, OHIO

- CLASSIFIED -

CHEMICAL ENGINEERS
PETROLEUM ENGINEERS
CHEMISTS

(Colloid, Physical, Inorganic)

Expanding progressive oil well servicing organization has openings for the above engineering classifications in a new research group. Nature of duties will include the conceiving and developing of methods for stimulating the production of oil and gas wells. In addition, develop products, equipment and techniques which can be used to accomplish the above and/or reduce the cost of servicing wells.

Minimum Requirements: PhD and 2 to 5 years research or oil field experience.

Salary commensurate with experience and ability.

THE WESTERN COMPANY
Employee Relations Department
P. O. Box 310
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KENTUCKY BLUE GRASS FARM FOR SALE

Beautiful, square shaped, 616 acres, gently rolling, Blue Grass farm, located in racehorse country, 5 miles from Paris, Kentucky, and 18 miles from Lexington, Kentucky, the heart of the famous Blue Grass section.

Fronts on a main thoroughfare (US 227), bounded on two sides by a black top county road. Year round water supply from Green Creek, running through middle of farm, fed by several never failing springs.

Rich, fertile, soil, very high in phosphate from underlying phosphoric limestone, producing excellent Burley tobacco. 1954 base of 21.5 acres. Ideal farm for all livestock—especially racehorses.

For further information contact owner, James C. Stone, Jr., either directly or through an agent, at 1218 Heyburn Building, Louisville 2, Kentucky. Telephone Clay 6336.

MECHANICAL ENGINEERS

Experienced in the design or operation of oilwell drilling and production equipment to work in the Los Angeles, California, area. Send a complete resume, including salary requirements to Box 177 c/o The Petroleum Engineer, 465 East Union, Pasadena 1, California.

EXPERIENCED RESERVOIR ENGINEER

An experienced, technically trained reservoir engineer is needed for unit operations. Must be graduate petroleum engineer, approximately 35 years old, with several years training in actual field operations and reservoir control. Please send details of training and experience to Box 159, care of The Petroleum Engineer, P. O. Box 1589, Dallas, Texas.

POSITIONS WANTED

Petroleum Engineer with Master's Degree, or Doctor's in Chemical, Mechanical or Petroleum Engineering, for research and teaching in Reservoir Mechanics and related fields at rapidly growing southwestern institution. Rank and salary open. Twelve months employment possible, consulting work encouraged and available in immediate area. Applications will be kept confidential. Box 160 C/O The Petroleum Engineer, Box 1589, Dallas, Texas.

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Petroleum Engineer. Services ten dollars per hour. Also technical, scientific and commercial translating. Rates on request. Advertising copy a specialty. Robert N. Jones, 3002 Dutton, Dallas 11, Texas. Phone ED 2-2688.

LOUISIANA PARADISE

Agriculture — Cattle
Wild Game

3000 acres most fertile delta land in south. 3 bales cotton per acre. Cattle natural range year round. Deer, Turkey, Squirrel and Ducks. Thirty-Forty Thousand dollars commercial timber. Thirty miles of fence. Good oil possibilities. Not leased. Quick sale —$75.00 per acre. Full description—write Dr. N. E. Wilson, Homer, Louisiana.

FOR SALE

Cooper-Bessemer Type 11 Compressor, twin engine, 2 cycle, 225 H.P. equipped with GMD 17" x 20" power cylinders and GD20 17½" x 20" Compressor cylinders.

Cooper-Bessemer Type 12 Compressor, twin engine, 2 cycle, 250 H.P. equipped with GMD 17" x 20" power cylinders, GD20 18" x 20" compressor cylinders, and Model D04T maxime exhaust silencer.

Waukesha Model WS-14E, 4 cylinder, 5¾" x 8", 90 H.P. engine, natural gas carburetor. 12 volt starting. Rebuilt in 1951.

Ingersoll-Rand ER1, 10" x 8" air compressor.

Gould 6" centrifugal water pump.

Write: Lumberport-Shinnston Gas Company
Lumberport, West Virginia

DEATHS

Oliver S. Ambrose, formerly of Westfield and Summit, New Jersey, manager of the economics and petroleum analysis department of Tide Water Associated Oil Company, died recently after a prolonged illness.

A Stanford University graduate, he joined Tide Water in 1920 as a construction engineer at its Drumright, Oklahoma, refinery. In 1928, he was named the petroleum analyst in New York and was transferred to the San Francisco, California, office in 1953.

Ronald S. Drysdale, a leading authority in the cutting oil field, died recently at his home, Prospect Park, Pennsylvania. He had been ill for many months. He served as special representative in charge of metal-working and cutting oils for Sun Oil Company, a position he held since 1920.

John Greer Bartram, 61, consulting geologist for Stanolind Oil and Gas Company, Tulsa, Oklahoma, died recently in Casper, Wyoming, of a heart attack. Bartram became division geologist for Stanolind in 1932, holding that position until 1939. He moved to Tulsa in that year as division geologist for the Central division, and in 1944 was made assistant manager of the exploration department. He became manager of the exploration department in 1947, and consulting geologist in 1950.

Joseph Waldeck, retired sales representative of the Lunkenheimer Company, Cincinnati, Ohio, died following a short illness. At the time of his retirement in July, 1949, he had been with the company for approximately 30 years.

Morris Price Macmillan, vice president in charge of production for Macmillan Petroleum Corporation for 30 years, died in California after a lingering illness. He was a pioneer developer of the Signal Hill oil field, California.

Charles J. Gregg, retired Appalachian district sales manager with Dresser Manufacturing division, died recently at his home in Bradford, Pennsylvania. He had been with the company 43 years prior to his retirement in 1948, having started as mail and file clerk in 1905. Gregg headed the payroll, order, traffic, purchasing and shipping departments during his employment at Dresser. Before becoming Appalachian district sales manager in 1929, he served as assistant general manager.

Harold James Wilson, manager of the western marine department of Tide Water Associated Oil Company, died recently at his home in Berkeley, California.

William DeWitt Waltman, pioneer oil executive and former director of Franco Wyoming Oil Company, died recently at his home in Los Angeles, California.

Carter Sheridan Bailes, a director of the Hancock Oil Company, died in Long Beach, following a heart attack.

J. R. Green, superintendent of Skelly Oil Company's West Texas-New Mexico district, died recently at his home. He joined Skelly in 1935.

THE OIL AND GAS RECORD $5.00 per copy

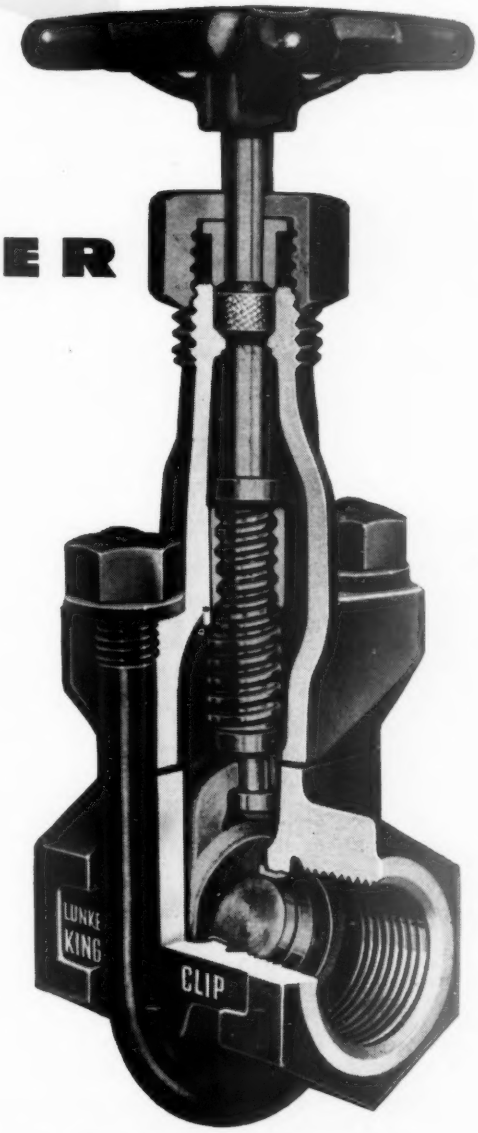
Directory of the Oil Industry in TEXAS (railroad Commission districts 2, 3, 4, 5, 6, 7 and 9. SO. ARK., WESTERN MISS., AND LOUISIANA. P. O. Drawer 5770, DALLAS, TEXAS.

Tightest gate valve . . . . . you ever used!

the original clip valve with the NEW **non-slip®** *handwheel**

King-clip®

by **LUNKENHEIMER**



It closes tight . . . it stays tight . . . and here are four good reasons why:

The new Non-Slip Handwheel provides a firmer, more comfortable grip for closing—even when the operator's hands are wet or greasy.

The body provides unusual ruggedness—protects the valve against distortion from wrenching or pipe stresses . . . and the steel clip permits quick disassembly and reassembly.

Extra thread length prevents pipe ends from jamming against diaphragm or seat rings to force them out of line. Threads accommodate both A. P. I. and standard threaded pipe.

Stemalloy* stems, in the Iron Body Bronze Mounted patterns, have amazing resistance to thread wear. Millions are in use, and *not one* has ever been returned due to wear failure.

LUNKENHEIMER QUALITY

BRONZE IRON STEEL

Ask your Lunkenheimer Distributor about "King-clip" — the original Lunkenheimer clip valve with cast-in drain channels and a bonnet-thread bushing for perfect stem alignment. For full details, request Circular 561 from your distributor or The Lunkenheimer Company, Box 360-X, Cincinnati 14, Ohio.

*Patented

LUNKENHEIMER®

THE ONE *Great* NAME IN VALVES

L-753-4

OIL and GAS TRADE NEWS

Mill Depot Established

A new mill depot has been opened by Wolverine Tube, division of Calumet & Hecla, Inc., for the Minneapolis, Minnesota, area. E. C. Humphrey, Jr., will coordinate the new mill depot operations through Wolverine's Minneapolis office.

Lane-Wells Opens Office

A new Lane-Wells division sales office has been opened in downtown Oklahoma City, Oklahoma, in the Liberty National Bank Building. The new office will be staffed by J. M. Terry and Robert L. Gregg, Jr., division sales engineers.

315 Graduate

Some 315 employees representing 204 companies in 33 states and 9 foreign nations were graduated from Minneapolis-Honeywell's industrial division training school in Philadelphia, Pennsylvania, in 1954. Among the corporations represented were Ford Motor Company, Standard Oil Company of New Jersey, Dow Chemical, General Foods Corporation, Hershey Corporation and Procter and Gamble.

Ureabor Introduced

The Pacific Coast Borax Company has introduced Ureabor, a new weed and grass killer developed specifically for industry. It will be marketed by the company's agricultural sales division.

McCormick Opens Office

McCormick Steel Company has just opened a Dallas, Texas, office in the Grace Building at 5622 Dyer Street. In charge of the new office will be Frank J. Flanagan, Jr., resident manager of sales.

Axelson Given Awards

Axelson Manufacturing company division of U.S. Industries, Inc., has received special awards of merit from the National Safety Council and the Aetna Insurance Company. These awards were presented to the company for an outstanding safety record of accident prevention performed over a six months' period.

HOMCO's quarterly Louisiana division meeting in New Orleans, Louisiana, was attended by: Seated, R. H. McClendon, Linn Galeener, T. C. Smith, George E. Justice, George O'Leary, E. H. Robertson, Bob Duke, Jimmy Erwin. Standing, are: R. H. Robbins, T. C. Burke, J. E. Kerr, W. A. Carlton, Ralph Creager, D. B. Allison, Weldon Medders, L. F. Jeter, C. W. Speights, Lou Armstrong, Al Eggleston, and Mack Standridge.

Subsidiary Established

The Stearns-Roger Manufacturing Company of Denver, Colorado, has established a subsidiary company in Canada known as Stearns-Roger Engineering Company Ltd. The headquarters are at Calgary, Alberta, where Robert T. Helmer, managing director, is in charge of the new company, which is wholly-owned by the parent company.

Girdler Builds Plant

The Girdler Company's new plant at Louisville, Kentucky, designed to increase production of its catalysts, is nearing completon. The plant, which represents an investment of $1,000,000 is the modern one-floor type of concrete, steel and aluminum construction.

ACF Expands Facilities

ACF Industries, Incorporated has completed additional facilities for the manufacture of pressure vessels. The new facilities include installation of a million dollar flanging press for production of a wider range of storage tanks and pressure vessels.

Air Filter Opens Office

A new branch office to handle the sale of Herman Nelson products has been opened in Denver, Colorado, by American Air Filter Company, Inc., Louisville, Kentucky. The new office will cover the Colorado and Wyoming district.

Beckman Buys Spinco

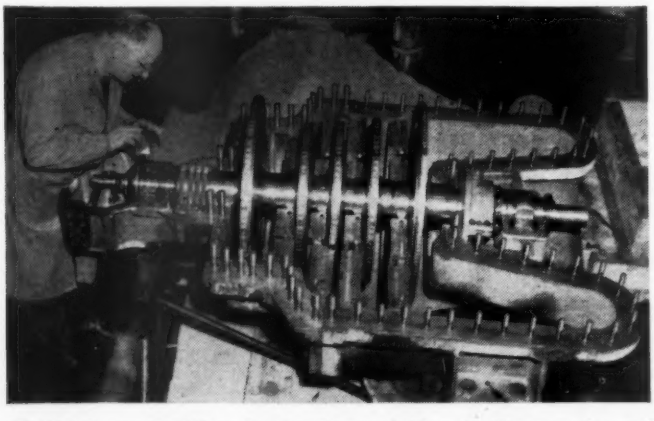
Beckman Instruments, Inc., of Fullerton, California, has acquired Specialized Instruments Corporation and Spinco Service Company, both of Belmont, California. These companies will be known as the Spinco division of Beckman and will retain headquarters and manufacturing facilities at Belmont.

Aeroquip Gains Subsidiary

Organization of a Candadian subsidiary, Prenco-Aeroquip, Ltd., Toronto, Canada, has been announced by Aeroquip Corporation, Jackson, Michigan. Prenco-Aeroquip, Ltd., is already in business having acquired all of the assets of Prenco Progress & Engineering Corporation of Toronto, Canada, relating to its flexible hose line and self-sealing coupling business.

Polyethylene Plant

The new 20,000,000-lb per-year polyethylene plant, recently placed in operation by the Texas Eastman Company at Longview, Texas, may have been completed more quickly than any similar facility, according to The Girdler Company, which handled the engineering work. The relatively short time that elapsed between the "go ahead" for the project and its completion was due in large measure, said Girdler officials, to the teamwork of Texas Eastman and Girdler engineers.



Skilled assembler in the General Electric Company's small turbine and supercharger department, Fitchburg, Massachusetts, is shown setting the upper-half of ball-seat bearing in place over turbine shaft. Turbine is part of one of four highspeed multistage DRV turbines manufactured by Fitchburg for Gulf Oil's new ethylene plant in its refinery at Port Arthur, Texas. Two self-aligning ball-seated-type bearings support the rotor.

Drilling Equipment Manufacturing Company's personnel and sales representatives attended a sales meeting in Oklahoma City. Standing, are: L. W. Mauck, Roy Wilkerson, W. B. Hickman, Terrell Jordan, N. J. Barnard. Seated, are: A. S. Herron, B. H. Phillips, J. G. Allen, R. C. Forrest, L. H. Matherne, C. G. Fager, C. L. Knight, P. R. Snetcher, M. T. Harrell, Russell Vaught, G. H. Osborn, A. C. Baldwin, Harry W. Denton and L. T. Waltmire.

Trade News

Lukens Enters New Field

Lukens Steel Company, Coatesville, Pennsylvania, plans to intensify product development to include diversification outside the capital goods field. Lukens, world's leading producer of steel plate, will commence the manufacture and marketing of end products and also enter markets foreign to the company's historical base.

Schlumberger Has Course

More than 50 companies served by Schlumberger Well Surveying Corporation were represented at four courses in electrical and radioactivity logging interpretation held in Schlumberger's Rocky Mountain Area during latter 1954.

Sales, Service Consolidated

Establishment of a consolidated sales and service department for the entire line of Marion-Osgood-General equipment in both the domestic and export markets has been announced by Marion Power Shovel Company. D. E. Rizor has been named to head the coordinated program as vice president for sales and service.

Cooling Towers Studied

A cooling tower laboratory operated by J. F. Pritchard & Company outside Independence, Missouri, is searching for the magic equation of cooling tower design. Engineers at the laboratory hope, after experiments are ended, to be able to evolve an equation which will enable them to predict the performance of cooling tower decking without actual testing.

Darling Opens Office

Darling Valve & Manufacturing Company has announced the establishment of a new sales office at 30 N. LaSalle Street, Chicago, Illinois. Heading all sales activities from this office will be B. E. Engstrom.

Sales Conference Held

The third general sales conference of Shand and Jurs Company, Berkeley, California, provided an opportunity for the men attending to get reacquainted at the factory and to observe the improvements in layout, machine tool equipment, and new production practices that have been instituted during the last few years.

Oil Base Names Distributors

Oil Base, Inc., Compton, California, has announced two new distributors for "No-Glo" oil, a non-fluorescing oil used in emulsion muds. Raymond S. Allred (doing business as Allred Oil Company) Odessa, Texas, has been appointed an authorized distributor in the West Texas area. Gulf Coast Pre-Mix Mud Service, Lafayette, Louisiana, will supply No-Glo on a non-exclusive basis to fields in and near south central Louisiana.

Isotopes for Oil Industry

Tracerlab, Inc., Houston, Texas, has established the first commercial laboratory solely for supplying radioactive materials to the oil industry. The new lab, already in operation, is headed by Leonard F. Tischler. The lab is prepared to make shipments on 24-hour notice.

Students Complete Program

The Trane Company has announced that 32 men have completed the 1954-55 engineering sales training program at the La Cross, Wisconsin, home office. All of the men are engineering graduates.

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And be 3 Ways SURE

...THAT THE MATERIAL IS RIGHT—all W-S steel couplings and reducers are in accordance with ASTM Specification A-105—Grade 2.

...THAT THE MACHINING IS RIGHT—threads or sockets are accurately machined—perfectly aligned.

...THAT THE IDENTIFICATION IS RIGHT—recessed figures on outside circumference clearly define the pressure rating and the material — and the unmistakable Double-Diamond trade mark is your assurance of high quality manufacture.

Watson-Stillman Couplings and Reducers in your piping system mean true economy. They give you long, trouble-free service, insure strong, leakproof joints and readily withstand the effects of shock and vibration.

Strengthen your piping system with these Watson-Stillman fittings. Screw-End Type available in 3,000 and 6,000 lb. class, sizes ⅛" to 6". Socket-Welding Fittings for schedule 40, 80, 160 and Double-Extra Heavy pipe in sizes ⅛" to 6".

Sold Through Leading Distributors

WATSON-STILLMAN FITTINGS DIVISION

H. K. PORTER COMPANY, INC.
Roselle, New Jersey

Swartwout Combines Divisions

Responsibility for sales and service for the roof ventilator division of The Swartwout Company, Cleveland, Ohio, has been assigned to the company's Southern California district office at Alhambra. Howard L. Joseph, district manager, who has been in charge of the companys power plant equipment and autronic process controls division, has been put in full charge of all Swartwout sales in the area.

Lane-Wells Gives Scholarships

Five of the Lane-Wells Scholarships awarded this year have gone to students born outside the United States. Two are Canadians, James M. Stewart of Shaunavon, Saskatchewan, and Alan Fraser Griffith of Edmonton, Alberta. John D. T. Scorer is from Bedhampton, Hants, England. Another scholarship winner, Dov Amir, born in Odessa, Russia, but has been resident of Israel since his first year. Howard DeKalb is really a product of Iowa, having been raised and educated in that state, but his birth place was Barranquilla, in Colombia.

Turkish Distributor Named

Enterprise Engine & Machinery Company, subsidiary of General Metals Corporation, San Francisco, California, has granted the Turkish franchise for distribution of all Enterprise products to Ali Kefeli, owner and manager of Kefeli A. Riza Company, Istanbul. The firm will concentrate on the municipal, industrial, and marine markets in its sales of engines.

Important Data on EXPLOSION RESISTANT SNUBBERS by BURGESS-MANNING

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Here is the answer to your surge and noise problems created by engines, compressors and vacuum systems. Burgess-Manning "BE" Snubbers are engineered to your specific need — designed to reduce that annoying exhaust roar to a smooth, quiet, and harmless discharge —and ruggedly built and internally reinforced to resist explosive pressures.

Profit through better neighbor and employee relations—avoid compensation claims.

BURGESS-MANNING COMPANY

Sound Engineering

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Dallas Chicago

Trade News

New Division Formed

Manning, Maxwell & Moore, Inc., has formed a new industrial controls division located in the company's Stratford, Connecticut, plant. Eugene M. Moore has been named manager of the division.

Turbines Ordered

Orders for mechanical-drive turbines, and turbine-generator sets amounting to approximately $860,000 have been received by the General Electric Company's small turbine and supercharger department. Two high-speed, multi-stage DRV turbines have been ordered for Gulf Oil Corporation's new fluid catalytic cracking unit in its refinery at Port Arthur, Texas. Also orders have been received for turbine-generator sets for the U. S. Maritime Administration's Navy Tanker Program.

Two-Way Radio for Trucking

Emergence of two-way radio in truck-freighting operations is foreseen by the Radio Corporation of America following establishment by the Federal Communications Commission of 20 radio frequencies for use by trucking firms. For the first time, the nation's motor carriers are now permitted intra-city radio operation on exclusive frequencies.

Atlantic Buys Computer

A second Marchant "Miniac" electronic digital computer has been delivered to Atlantic Refining Company for petroleum research applications. The computer is now in use at the Dallas, Texas, laboratories of Atlantic Refining Company's research and development division.

Noise Seminar Conducted

A special noise seminar was conducted recently at the Petroleum Club of Shreveport, Louisiana, attended by representatives of the gas pipeline companies. Norman L. Meyerson, assistant manager of research & development at the Worthington Corporation's Harris, New Jersey, Works, spoke on noise measurement and evaluation.

Republic Supply Opens Store

Republic Supply Company has opened a new store at Medicine Lodge, Kansas. Marion C. Tener was named manager of the store.

Pritchard Representatives Named

J. F. Pritchard and Company of California, Kansas City, Missouri, has appointed two new sales representatives to handle Pritchard products in the southern United States. J. L. Brownlee and Gordon Morrow comprise the Brownlee-Morrow Engineering Company in Birmingham, Alabama, and represent Pritchard of California in Alabama and the western tip of Florida.

Dow Enters Netherlands

The Netherlands Minister of Economic Affairs has granted The Dow Chemical Company permission to establish a wholly-owned subsidiary company, to be known as Nederlandsche Dow Maatschappij N. V., in Rotterdam, Netherlands. The Dow application to do business in the Netherlands, as approved by the Dutch government, permits the subsidiary to import, manufacture and distribute domestically and abroad a variety of chemicals, plastics, and magnesium.

Burgess-Manning, Penn Merge

Shareholders of Burgess-Manning Company, of Libertyville, Illinois, formally approved a plan of merger under which Penn Industrial Instrument Corporation of Philadelphia, Pennsylvania, has been merged into the Libertyville company. Burgess-Manning, which maintains divisional offices in Chicago, Illinois, and Dallas, Texas, in addition to its Libertyville office, will continue the manufacture of industrial silencing equipment and architectural acoustical products. The Penn business, consisting of the manufacture of industrial instruments, will be continued as a division of Burgess-Manning. The Burgess-Manning shareholders also elected William C. Bennett and William Melas, the former principal executive officers of Penn, as directors of the merged company.

Kaiser Buys Union Steel

Kaiser Steel Corporation has purchased the plant and facilities of Union Steel Company. Union Steel is a major steel fabricating and erection firm in east Los Angeles, California, employing approximately 300 workers.

Fisher Buys Factory

Fisher Governor Company, Marshalltown, Iowa, has purchased a factory building in Woodstock, Ontario, Canada, and will start manufacturing operations there this spring. The plant in Woodstock, constructed in 1952, is a modern one-story building with 17,250 sq ft of space. Fisher diaphragm motor valves, liquid level controllers, and gas regulators will be manufactured there.

Chiksan Negotiates

Food Machinery and Chemical Corporation has entered into an agreement with the Chiksan Company whereby it will offer to exchange one share of Food Machinery and Chemical Corporation common stock for 2.30 shares of Chiksan Company common stock of which there are 260,264 shares outstanding. It was indicated that the agreement will substantially broaden FMC's current position as a producer of equipment and materials for the petroleum industry and other specialized industrial fields. The new operation will function under its present management as the Chiksan division of FMC.

Drives Sent to Argentina

The Export division of The National Supply Company has supplied two dual engine pump drives to Yacimientos Petroliferos Fiscales (ENDE) (Argentine Government Oilfields). The two large capacity high power pump drives will be used with existing heavy duty rigs for drilling to depths beyond 15,000 ft.

Clark Opens Office

Clark Brothers Company of Olean, New York, has opened a new district sales office in Atlanta, Georgia. Acting as district manager of the territory is Richard Foster.

Ampco Distributor Named

Ampco Metal, Inc., Milwaukee, Wisconsin, has announced the appointment of The St. Catharines Brass Works, Ltd., St. Catharines, Ontario, Canada, as a distributor of several Ampco stock products.

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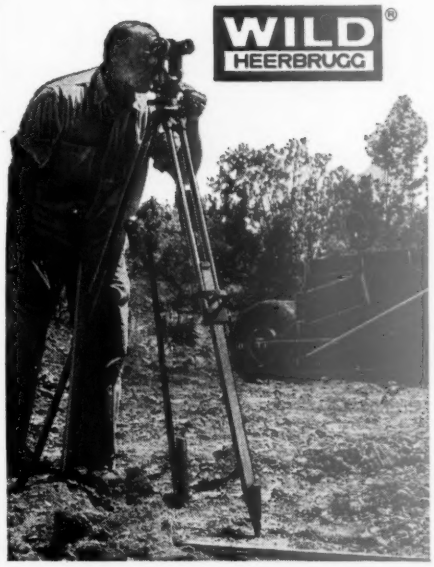

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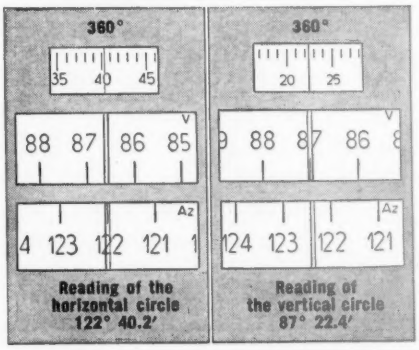

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Trade News

Tidelands Speed Building

Tidelands developments on the Gulf Coast have brought accelerated work schedules to Todd Shipyards at Houton and Galveston, Texas, and New Orleans, Louisiana. The Houston shipyard employed a new method in the final assembly of a drilling structure for the Pure Oil Company's "Rollover B" field in the Gulf of Mexico. Todd substituted the use of a 12,000 ton floating drydock for the usual heavy lift crane to load the finished units onto barges. This was the first time a floating dry dock was used for off-loading heavy off-shore structures.

Honing Building Completed

Fluid Packed Pump Company recently announced the completion of a large new honing building, another step in their current $750,000 plant expansion program. This program has been underway for about a year and is scheduled for completion in 1956.

Retainer Output Increased

Roller pockets for the bronze retainers of precision radial and thrust roller bearings are machined in one operation at Rollway Bearing Company, Syracuse, New York, on two automatic indexing air-hydraulic drill units. Designed and engineered by Rollway, the new machines drill and ream both radial and thrust retainers, which vary in size from 2- to 14-in. oustide diameter and from ¼-in. to 1¼-in. drill diameter. Index cycle of the units is two seconds, contributing directly to a 100 per cent increase in output over production runs previously machined in two operations, company said.

Bakelite Names Distributor

Chicago Bridge and Iron Company has been appointed as a distributor of microballoons, C. W. Blount, vice president in charge of sales for Bakelite Company, a division of Union Carbide and Carbon Corporation, has announced. Chicago Bridge and Iron plans to concentrate its marketing activities for the present on those situations in the petroleum industry to which the use of this new material is particularly suitable.

J&L Wire Rope Pioneers

Jones & Laughlin Steel Corporation at Muncy, Pennsylvania, has developed and introduced a wire rope with a core of noncorrosive, acid-resistant polyvinyl plastic. Also one has been developed with a core of coiled steel spring, another with a specially designed center which contains electrical thermocouples to determine changes in temperature all along the length of the rope. The J&L wire rope division plant at Muncy produces more than 7000 miles of wire rope products every year.

Parkersburg Moves

The offices of the Parkersburg Rig and Reel division of Parkersburg-Aetna Corporation has been transferred to Fort Worth, Texas, from Parkersburg, West Virginia.

McCullough Opens Branch

McCullough Tool Company has opened a new service branch at Abilene, Texas. James Northcott has been placed in charge as branch manager. He was tansferred from McCullough's Cisco branch where he had also served as branch manager. The Abilene branch brings the total number of McCullough offices to 51.

Holliday J & L Division

Jones & Laughlin Steel Corporation has announced that the recently-acquired firm of W. J. Holliday & Company, Inc., Indianapolis and Hammond, Indiana, is the W. J. Holliday & Company, division of J&L. Holliday's affiliate firm, Monarch Steel Company, Hammond, became J&L's Monarch steel division. C. H. Bradley, president of W. J. Holliday & Company, and of Monarch, became chairman of the advisory board of the W. J. Holliday & Company division. George L. Stewart, vice president and general manager of W. J. Holliday & Company, Inc., and executive vice president of Monarch Steel, president of the W. J. Holliday & Company division.

Schlumberger Opens Office

Schlumberger Well Surveying Corporation has opened a new office and service point in Sterling, Colorado, to serve oil producers in the Denver-Julesburg Basin. With the opening of the new location Schlumberger will have more than 130 field locations in the United States and Canada. H. F. Soerensen will be in charge of the new location and M. D. Kline, engineer, has been transferred from Sidney, Nebraska, to assist in carrying out field operations.

B-L-H Buys Madsen

Baldwin-Lima-Hamilton Corporation has announced the purchase of the Madsen Iron Works, located at La Mirada, California, from the California interests headed by Martin Madsen, who founded the company in 1910. Martin Madsen retired and was succeeded as president of Madsen Iron Works, Inc., by Henry Barnhart.

Micro Opens Offices

Establishment of new sales and engineering offices in Phoenix, Arizona, Charlotte, North Carolina, and Denver Colorado, is announced by Micro Switch, a division of Minneapolis-Honeywell Regulator Company. Ralph C. Froehlich heads the new Phoenix office; Donald S. Schultz has charge of the Charlotte office, and Richard J. Petersen is in charge of sales and engineering in the Denver area.

Borax Has Conference

The bulk sales department of the Pacific Coast Borax Company, division of Borax Consolidated, Limited, has just completed its annual sales conference. General chairman of the conference was J. F. Corkill, vice president, bulk sales. Guest speakers included G. J. Buerman, director of purchases, Ferro Corporation of Cleveland, Ohio, and K. D. Lozier, vice president, St. Regis Paper Company, New York, New York.

General Controls Expands

Construction has begun on two additional facilities at the General Controls Company's plant in Glendale, California. A 15,000 sq ft addition is being added to the present engineering area and will be used for both tooling and engineering, particularly in the research and development phases. A second story is being added to the main administrative building, increasing the office area by one-third.

Consultants Named

Catalytic Construction Company of Philadelphia, Pennsylvania, has engaged the Sheppard T. Powell Organization of Baltimore, Maryland, as consultants to supplement Catalytic's engineering and technical staffs in solving water problems that arise in the design, engineering and construction of new plants.

Sales Office Added

Houston Oil Field Material Company, Inc., has opened a new sales office in Enid, Oklahoma. H. D. Robinson is resident manager for the new location. The Enid office will operate in conjunction with the Tulsa office of Homco.

Honan-Crane Changes Name

The name of Honan-Crane Corporation, Lebanon, Indiana, has been changed to Houdaille-Hershey of Indiana, Inc. Honan-Crane has been operated as a subsidiary of Houdaille-Hershey Corporation for the past ten years and is one of the pioneers in the oil and coolant filtration fields. The name "Honan-Crane" will be retained to identify the new company's oil filter equipment.

Dowell Opens Sales Office

Dowell Incorporated, oil well and industrial servicing company, has opened offices in the Fidelity Union Life Building in Dallas, Texas. C. R. "Clancy" Olson, sales engineer, has been transferred to the new office from the company's office in Oklahoma City. The Dallas office is the fourth general sales office opened by Dowell.

Bethlehem Opens Store

Bethlehem Supply Company has opened a new store at Sweetwater, Texas. Henry Dodds, field representative, will cover the oil field sales in the area and Vernon Stevens will be chief clerk in the store.

GE Completes Structure

A new structure has been completed to house General Electric's welding sales branch at Tulsa, Oklahoma. The building, which includes offices, service, and warehouse facilities, will serve Colorado, Wyoming, Kansas, Arkansas, and Oklahoma.

Childers Appoints

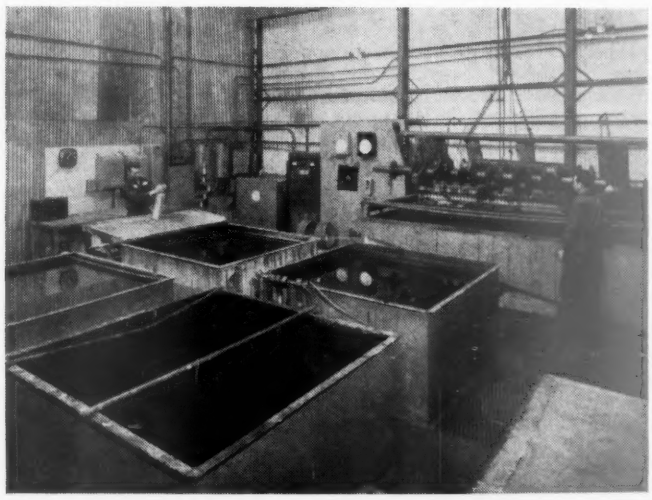
Childers Manufacturing Company, Houston, Texas, announces the appointment of Power Plant Efficiency Company, Indianapolis, Indiana, as sales and engineering representatives of aluminum weather-proof jacketing. Power Plant Efficiency's territory will consist of central Indiana including Fort Wayne and Evansville.

Company also appointed the P. J. O'Meara Company, San Francisco, California, as sales and engineering representatives for aluminum jacketing for insulated lines. The O'Meara territory will include northern California and the State of Nevada.

Atlas in New Building

Atlas Powder Company has moved general offices to its own building on a 45-acre tract about three miles from downtown Wilmington, Delaware, on Concord Pike and New Murphy Road. The new building, under construction for 14 months, will provide additional space as well as the most up-to-date facilities for the company's office staff.

Fluid Packed Pump Company, manufacturer of Oilmaster Downwell Pumps and production equipment, has completed a large new raw materials warehouse at its Los Nietos, California, plant as a part of its current $750,000 plant expansion program. This picture shows part of current stock of 1000 tons (40 carloads) of steel tubing materials.



M-C-M Machine Works Company has begun operations in its modern hard chrome plating plant at Oklahoma City, Oklahoma, said to be the only one set up for the specific purpose of serving the oil country. With one of the largest plating vats in the Southwest, MCM can accommodate any part up to 8 ft wide, 14 ft long or 8 ft deep.

TRADE PERSONALS

Hal Messinger

M. T. Works

R. E. Budde

R. E. Parry

Hal Messinger has been promoted to general sales manager for the Baash-Ross Tool Company. His headquarters will be in Houston, Texas, where he will have charge of domestic and export commodity sales for the company.

Pioneers Specialties, Inc., has announced the election of **Madden T. Works** as president. Works, a mechanical engineering graduate of Rice Institute, has been connected with the oilfield specialty equipment business since before finishing college. He has more than a score of patents to his credit and just prior to joining Pioneer was engaged in product development work for his own account.

Dr. A. B. Steele has been appointed manager and **C. P. McClelland** has been appointed assistant manager of technical service for Carbide and Carbon Chemicals Company, a division of Union Carbide and Carbon Corporation. This newly-created technical service group will be responsible for rendering special technical assistance to Carbide's customers.

John H. Mathewson has been transferred from the Philadelphia district office to the Fine Chemicals division of Carbide. He will work on the market development of Flexol plasticizers for vinyl plastics, nitrocellulose lacquers, and associated fields.

Lee L. Tompkins has been appointed administrative assistant to **John F. Younger,** vice president of research and development for The Western Company. Tompkins will plan and coordinate methods and procedural work in the research and development division.

Fred S. Shumaker has been named district representative of the Michigan sales area for Leschen wire rope division, H. K. Porter Company, Inc. The territory covers the lower peninsula of Michigan and part of the upper peninsula.

Paul L. Gallagher has beeen appointed manager of pipe sales for the Claymont Steel Products department of The Colorado Fuel and Iron Corporation. He will be located at the Claymont Steel products sales office in Wilmington, Delaware.

Link-Belt Speeder Corporation has announced the appointment of two new sales executives, **C. (Cal) M. Basile** is vice president of manufacturing and sales, and **Gordon W. Rowand** has been promoted to sales manager. Both men will headquarter at Cedar Rapids, Iowa.

The Swartwout Company, Cleveland, Ohio, has announced the appointment of **Robert E. Budde** as regional product manager for the Midwestern area. He will be responsible for Autronic sales and service in Illinois, Wisconsin, Minnesota, North and South Dakota, Nebraska, Iowa, northern peninsula of Michigan, and eastern Missouri.

Ray E. Parry has joined the France Packing Company as a sales representative and territory manager. He will operate in Michigan, Ohio, Indiana, and Kentucky.

James B. Zachry has been appointed Worthington Corporation special southwestern representative in charge of sales to gas pipe line companies. Associated with shop testing, application and sales of engines since joining Worthington in 1939, Zachry is an engine specialist and has been assigned to the Southwestern regional sales organization for the past year. In his new post Zachry will continue to headquarter in Houston, Texas.

Johnston Murray

W. O. Satterwhite

W. L. Carwile, Jr.

Paul Courtney

Johnston Murray, ex-governor of Oklahoma, has been voted a vice president of Welex Jet Services. Murray's work with Welex will closely parallel his earlier oil experience. He will be in charge of the company's foreign activities and spend a large part of the time overseas.

W. O. Satterwhite has been elected vice president—West Texas division of Welex. He joined Welex as assistant manager and salesman in the Odessa district October 1, 1948. Satterwhite will continue to maintain his offices in Midland, Texas.

W. L. Carwile, Jr., has been elected vice president—Oklahoma division. Carwile, who joined Welex in 1948, became Oklahoma division manager May 1, 1950.

R. E. "Gene" Dixon has been appointed sales engineer for the Ardmore, Oklahoma, district of Welex.

Frank Thorne, technical writer and authority on advertising production, has joined the staff of Darwin H. Clark Company as a technical writer and production manager. For the past five years, he has been advertising manager of Baker Oil Tools, Inc., of Los Angeles, California, and Houston, Texas.

Appointment of **Francis T. Greenup** as chief design engineer has been announced by Consolidated Engineering Corporation, Pasadena, California. He will direct activities of a section responsible for new product design, engineering drawing, and operation of the Model Shop, where parts for model instruments are constructed for laboratory use.

Richard L. Erlin has been named manager of engineering sales for Kaiser Steel Corporation in Oakland, California. Before assuming his present post, Erlin served as assistant to the vice president, sales, for the Louis Berkman Company of Steubenville, Ohio.

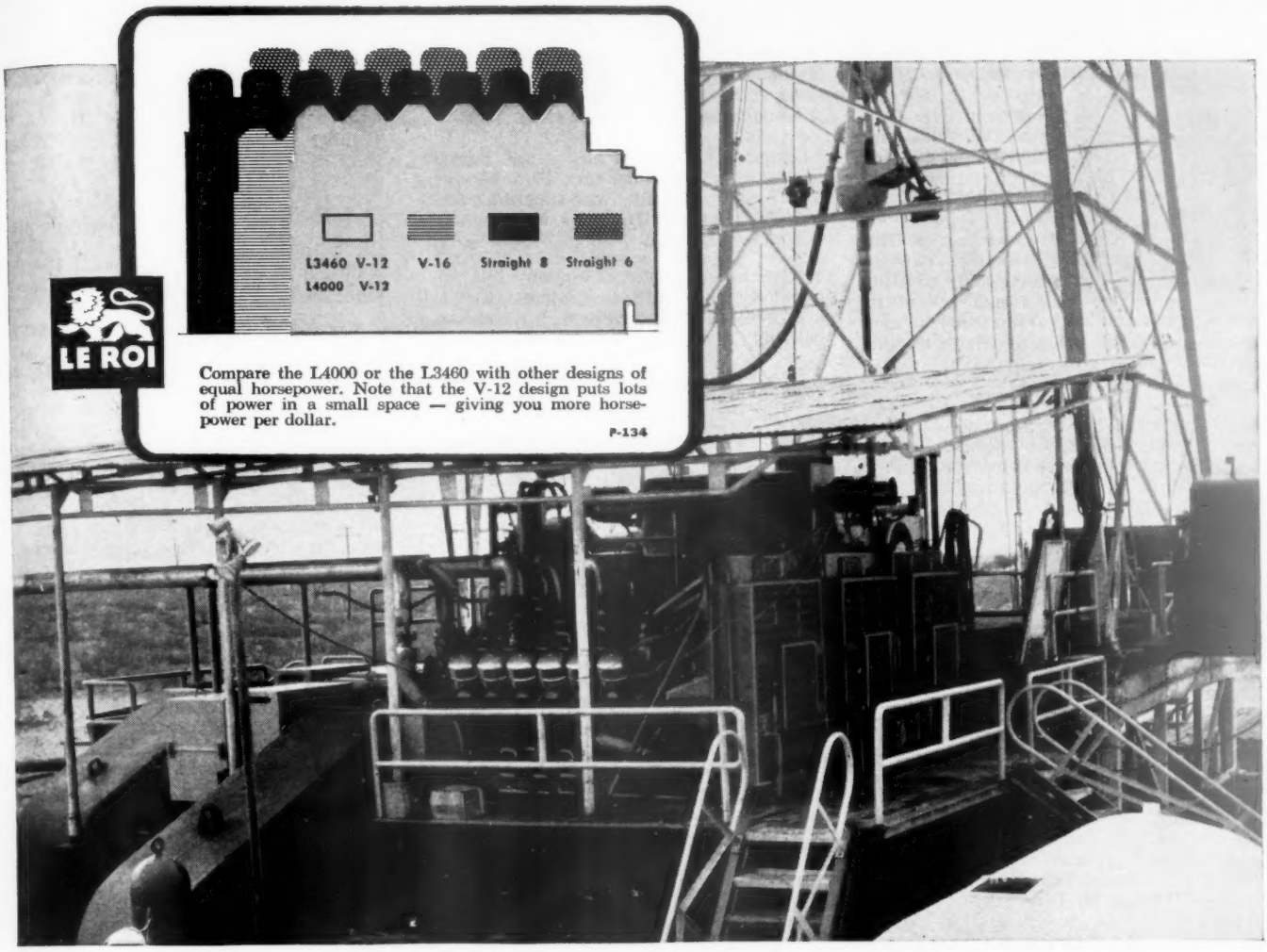
I. A. Schwint has joined the Petroleum Catalyst department, Davison Chemical Company division of W. R. Grace & Company for sales and service contacts with petroleum refiners in parts of the eastern United States. He went to Davison from the Filtrol Corporation, where he was eastern representative.

Warren H. Brand has been elected vice president in charge of engineering and research by Conoflow Corporation. His duties at Conoflow include supervision of administrative functions of the engineering department and intergration and expansion of research and development programs. Brand joined Conoflow in 1954 as director of engineering and research.

Ted Sutter, executive vice president and general manager of Baker Oil Tools, Inc., has been elected a vice president of the Merchants and Manufacturers Association.

Paul Courtney of Tulsa, Oklahoma, has been named president and director of the George E. Failing Company of Enid, Oklahoma. He succeeded **R. W. Morgan,** general manager of the Cleveland rock drill division of Westinghouse, who had been serving temporarily as president of the Failing Company. Courtney has been president of Unit Rig and Equipment Company.

E. C. Humphrey, Jr., has been appointed sales representative in the upper peninsula of Michigan, Northwestern Wisconsin, Minnesota, and North and South Dakota, for Wolverine Tube, division of Calumet & Hecla, Inc. Formerly a sales representative for American Machine & Metals Company, Humphrey will headquarter in Wolverine's Minneapolis, Minnesota, office.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L4000 V-12
V-16
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Straight 6
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Compare the L4000 or the L3460 with other designs of equal horsepower. Note that the V-12 design puts lots of power in a small space — giving you more horsepower per dollar.
P-134

An engine doesn't have to be BIG to be POWERFUL!

The compact, V-12 design of Le Roi's L4000 and L3460 proves it!

Le Roi's L4000 and L3460 engines represent the first truly new design concept in 15 years. They are compact high-output engines, designed with short stroke to give you greater horsepower and speed without compromising engine life.

In addition to the advantages of short-stroke design, these modern V-12's have lightweight pistons, short-radius rotating parts — hydraulic tappets — crankshaft vibration dampener — sensitive controls. That's why they give you hair-trigger response to load demands.

The fuel economy of these engines is good, too. Thanks to advanced-design manifolding, low friction bearings, and low power loss to accessories, they give you rock-bottom fuel consumption.

Yes, big surprises come in small packages. That's especially true of the L4000 and L3460. These engines are conservatively rated to give you plenty of power in reserve. The L4000, for example, provides 635 max. hp. and the L3460, 600 max hp. And they have a wide speed range, too, up to 1350 rpm. That's why these engines are ideally suited to a great many oilfield applications: drilling, pipeline station, generator, gas booster, etc.

Engines may come bigger than these Le Roi's, but they sure don't come better! See for yourself — ask your supply house or Le Roi distributor to show you an L4000 or L3460 at work. Call him soon. Bulletins are also available — just write for them.

LE ROI *Division of Westinghouse Air Brake Co.*

Milwaukee 14, Wisconsin
Oilfield Headquarters: Tulsa, Oklahoma

Trade Personals

Robert M. Sherrard has been appointed district representative at Casper for U.S. Steel's Oil Well Supply division. Sherrard came to his new post from Olney, Illinois, where he had served as district merchandise manager since 1951. He joined Oilwell in 1937 at Casper. The following year he transferred to Illinois and served in various sales and managerial posts at Salem, Clay City and Mattoon, Illinois, prior to becoming district merchandise manager.

R. M. Sherrard

Eldon E. Fox has been promoted to the newly-created position of director of advertising and sales promotion for Minneapolis-Honeywell Regulator Company. Fox formerly was advertising manager.

R. A. Schlegel and **J. F. Smith** have been appointed associate sales managers for the oil and chemical industries for the industrial division.

International Harvester Company has announced the appointment of **W. F. Hall** as manager of the company's industrial power central sales region. Hall replaced **L. A. Coomer** who was transferred to the company's eastern sales region.

International has also named **Donovan Stevens** to be in charge of industrial power sales to national user accounts. He will work in the sales development section on sales to railroads, airlines, pipeline companies, and other national buyers of International industrial power products. He replaced **Walter H. Tudor,** who was appointed industrial power territory manager for the Chicago area.

American Hoist & Derrick Company of St. Paul, Minnesota, has named **William Niessen** and **Kenneth F. Potter** to the positions of assistant chief engineer.

J. F. Pritchard and Company, Kansas City, Missouri, has named **W. W. Bodle,** former manager of the process and research department, as office manager. Bodle was graduated from Yale University with a BS in chemistry and obtained an MS in chemical engineering from New York University. He joined the Prichard organization in 1946.

Frontier Chemical Company, a division of Union Chemical and Materials Corporation, has announced the appointment of a resident salesman, **Jack M. Calkins,** in the St. Paul-Minneapolis area. He will handle sales activities for a nine-state area, including Minnesota, North and South Dakota, Wisconsin, Iowa, Nebraska, Missouri, Illinois, and Indiana.

C. B. "Ike" Truitt has joined Diamond Oil Well Drilling Company as general sales manager. A graduate of the University of Oklahoma School of Mechanical Engineering, Truitt was formerly with Hanlon Waters, Inc., A. O. Smith Corporation, Grove Regulator Company, and Hiwan Petroleum Company.

Thad Randolph, vice president and sales manager of Oil Base, Inc., has been named executive vice president and general sales manager. **A. K. "Deacon" Brown,** former Mid-Continent sales manager, has been appointed vice president and division manager.

The board of directors of Beaver Pipe Tools, Inc., Warren, Ohio, has elected **Max E. Chandler** controller and treasurer. Prior to joining Beaver, Chandler was associated with the Western Reserve Lumber Company as secretary and accountant.

Eugene J. Cassella has joined Beaver as assistant plant manager. Prior to joining Beaver, Cassella was superintendent of The Bingham-Hebrand Corporation, Fremont, Ohio.

Caterpillar Tractor Company has appointed **D. F. (Don) Coonan,** former earthmoving representative, as special pipeline representaive in domestic sales.

Retirement of **George A. Hanson,** veteran credit man in the Dallas, Texas, offices, after 32 years service, has been announced by U.S. Steel's Oil Well Supply division.

Wallace L. Reed has been appointed district engineer at Houston, Texas.

Three appointments in the West Texas district of U.S. Steel's Oil Well Supply division have been made. **Winifred Berl Potts,** storeman in the Big Bend, Texas, store, has been promoted to field representative at that city. **Richard E. Yates,** field representative at Odessa, Texas, has been named manager of the Sundown, Texas, store. **Joe Lloyd Ward,** storeman at Odessa, Texas, has been promoted to field represenative at that location.

Transfer of **Armand Vaussine,** field representative at Lake Charles, Louisiana, for U.S. Steel's Oil Well Supply division, to New Iberia, Louisiana, in the same capacity has been announced.

Appointment of **Joseph P. Green** as director of engineering for The Swartwout Company, Cleveland, Ohio, has been announced.

Company also has appointed **Ernest H. Bellard** as vice president in charge of sales, and **William H. Krueger** as treasurer and controller.

Paul H. Strehle, Jr., has become regional product manager of the Autronic process controls division.

The appointment of **Harold M. Aitkenhead** to district sales manager of the St. Louis, Missouri, office of ACF Industries, Incorporated, has been announced.

R. W. Mossman and **R. B. Baum** have been elected assistant vice presidents of Seismograph Service Corporation. Mossman will be in charge of the northern division of the exploration program at Baum will head the southern unit.

William M. Rice has been named treasurer of Transcontinental Gas Pipe Line Corporation. Prior to the promotion, Rice was assistant treasurer in charge of taxes. He came to Transcontinental from Washington, D.C., where he had been a member of Walker, Rice & English, a law firm handling tax matters. **S. L. Lamkin,** former supervisor of general accounting, has been named assistant controller.

Ralph W. Seely has been appointed vice president in charge of sales of Columbia-Geneva steel division of U. S. Steel, succeeding **Marcus J. Aurelius.** Aurelius has been appointed vice president and general sales manager for U.S. Steel at Pittsburgh, Pennsylvania.

Paul D. Sullivan has been named assistant sales manager by Le Roi division, Westinghouse Air Brake Company. He will headquarter in Milwaukee.

T. C. Williams, executive vice president, Stone & Webster Engineering Corporation, Boston, Massachussetts, has been elected president of National Constructors Association. Williams succeeded **John F. O'Connell,** vice president, The Bechtel Corporation, San Francisco. **C. D. Haxby,** vice president, The Rust Engineering Company, was elected vice president and **C. B. Bronson** was re-elected secretary-treasurer. Committee heads named by the association are:

T. C. Williams

Labor committee, chairman, **P. L. Wetcher,** C. F. Braun & Company; co-chairman, **Eric Miller,** The H. K. Ferguson Company; and **J. E. Quinn,** Procon Incorporated.

Safety committee, chairman, **J. G. Hand,** Foster Wheeler Corporation; co-chairman, **C. A. Clore,** The Girdler Company.

Foreign committee, chairman, **J. F. Ryan,** Foster Wheeler Corporation; co-chairman, **R. E. Atkinson,** Koppers Company.

G. N. Thresher, chief engineer, Dowell construction engineer and **E. J. Ehcols,** development engineer, is now chief design engineer. Thresher will be responsible for all field operations and maintenance of equipment, radio communications, equipment records, manuals and bulletins. The construction engineering department under Aurand, will handle design and construction of station facilities.

The S. R. Bowen Company, Santa Fe Springs, California, has announced the appointment of **James Bayliss,** Astor Court, Warf Street, Brisbane, Australia, as their representative in Australia, British New Guinea and New Zealand.

Bonney Forge & Tool Works, Allentown, Pennsylvania, has announced that the board of directors has elected **Spencer H. Mieras** and **Kenneth W. Foust** to fill two vacancies on the board. In addition, Mieras was elected to the post of executive vice president.

The H. K. Ferguson Company has announced the appointment of **Robert R. Cutler** as vice president and central district manager. **C. J. Haglund** was named vice president and manager of Ferguson's western district office.

Thomas W. Johnson has been appointed director of engineering of the New York Air Brake Company.

S. G. Paddock, manager of the Dallas division of Burgess-Manning Company, has been elected a vice president of the company. Paddock also is a sales director of the company.

M. S. Black, formerly plant superintendent, has been promoted to works manager for Fluid Packed Pump Company. In assuming the responsibilities of this assignment, Mr. Black will assist management in charting overall company and manufacturing policies. **Gordon Satterla,** formerly assistant to Black, has been appointed plant superintendent, and will be directly responsible for all phases of manufacturing and plant operation.

Kenneth Davis, Jr., has been elected a director and named president of Unit Rig & Equipment Company. Davis replaced the former president, **Paul Courtney.**

Clarence M. Holden, former president of the General Industrial Supply Corporation of Fort Worth and until recently contract administrator for Rohr Aircraft Corporation of California, has been named representative for Born Engineering Company in the Texas area.

Wallace G. Alexson has joined the staff of the contract sales department of The M. W. Kellogg Company. A chemical engineer, Alexson most recently was in charge of crude evaluation work for the Esso Standard Oil Company.

P. L. Griffith has been appointed director of industrial development for Walter Kidde Constructors. Griffith was formerly associated with Sanderson & Porter, a New York engineering firm.

Great Bend Fishing Tool Company of Great Bend, Kansas, an affiliate of Acme Tool Company, Oklahoma City, has appointed **Tom Seago** as manager of its Liberal, Kansas, Fishing Tool Shop. Seago replaced **C. N. "Shorty" Hughes,** who has been assigned to Great Bend's new fishing tool shop at Borger, Texas.

Howard N. Farmer, Jr., has joined the development and research division of The International Nickel Company, Inc., as a member of the West Coast technical field section at Los Angeles, California.

B. J. "Barney" Osborne has been appointed assistant to the vice president and general manager of Kaiser Steel Corporation and placed in charge of the company's fabrication division.

John F. Gardner has been appointed to the position of director of employee and public relations for Fluor Corp., Ltd. Formerly he was administrator for foreign subsidiaries for Fluor and has been with the concern for 15 years.

James L. Neal, Dallas, Texas, sales manager for Owens-Corning Fiberglas Corporation has been named the company's southern regional sales manager.

Bethlehem Supply Company has announced several personnel changes in its North Central Texas district. **J. P. Chance,** city salesman at Wichita Falls, has been promoted to store manager. He succeeded **H. E. Williams,** who became chief clerk to **W. E. Stephenson,** district manager at Wichita Falls.

L. T. Little, machinery serviceman at Wichita Falls, has been transferred to Abilene and promoted to field salesman. **D. A. Hutson,** pump shop operator at Abilene, has been promoted to field salesman at the same point. **B. J. O'Dell,** formerly chief clerk, has been promoted to assistant store manager at Whitesboro, Texas. **R. E. Ligon,** chief clerk at San Angelo, has been promoted to field salesman and transferred to the Whitesboro, Texas, store.

Computer systems engineers **Jack C. Van Paddenburg** and **Robert Sanekoff** have been attached to the eastern regional headquarters of ElectroData Corporation.

John R. O'Connor of Graver Tank & Mfg., Company, Inc., has been named manager of sales, central division. O'Connor formerly headed Graver's office in Atlanta, Georgia, and was in charge of southeastern sales.

M. J. Boho, vice president and general manager of Hagan Corporation, has been elected a director of Hagan and its subsidiaries, Calgon, Inc., Hall Laboratories, Inc., and The Buromin Company. A graduate of Lafayette College, he joined the firm in 1936.

Semon E. Knudsen has been named general manager of the Detroit diesel division of General Motors. Knudsen succeeded **William T. Crowe,** who retired after 35 years' service.

William H. Kinney has been appointed resident metallurgical engineer for Kaiser Steel Corporation in Oakland, California.

Huntly Briggs has been appointed assistant advertising and sales promotion manager for General Controls.

R. M. Hammes has been appointed general sales manager of the Niagara Filters division and the Tolhurst Centrifugals division of American Machine and Metals, Inc., East Moline, Illinois, succeeding **F. C. Weicker** who has resigned.

The Pall Filtration Companies have appointed **Evan R. Rotner** to their research and development staff. Rotner was formerly with the Stauffer Chemical Company at its carbon disulfide research center at Chauncey, New York.

The Pacific Coast Borax Company has appointed **W. J. Dibble** as general sales manager, western division, bulk department. The agricultural sales division has announced the appointment of **F. M. Dosch** as manager of its district office in Kansas City.

Robert F. Lay has been promoted to general sales manager of The Cooper-Bessemer Corporation. **Grant C. Woodard** has been appointed assistant general sales manager.

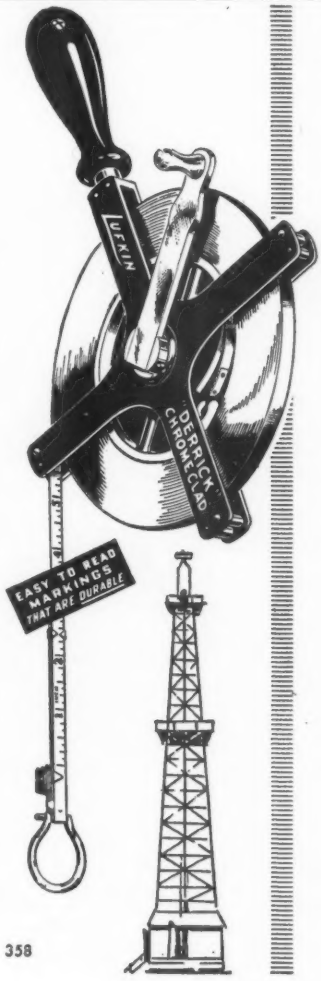
The American Cast Iron Pipe Company, of Birmingham, Alabama, has announced the promotions of five officials. **Stephen D. Moxley,** former executive vice president, has been named president to succeed **Charles Otto Hodges** who retired after 38 years of continuous service.

Others who assumed top posts at Acipco were **Frank H. Coupland,** who became vice president and works manager; **Arnold J. Herrmann,** who was named vice president and sales manager; **Kenneth R. Daniel,** vice president and chief engineer, and **A. E. Brown,** treasurer.

Roger E. Risley has been named director of engineering and **Fred T. Newell,** chief product engineer, by Dresser Manufacturing.

V. V. Malcom, sales manager of the Philip Carey Mfg. Co., Concinnati, Ohio, has been appointed vice president and general manager of Perrault Equipment Company. Malcom, an engineer by training, joined the firm as a field engineer in 1927.

Lloyd Logsdon, retiring vice president and general manager of the Mueller Company west coast sales and plant operations in Los Angeles, California, was honored by more than 400 business and financial executives who attended a testimonial dinner. **William H. Hipsher,** executive vice president, led the tribute.



358

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CHROME CLAD STEEL TAPE

The Lufkin "Derrick" — designed by oil men — is the first choice for measuring casings in derricks and many other oil field jobs. Here's why:

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- Permanent jet black markings — bonded to steel — graduations extend to edge of line.
- Line is extra heavy weight — fully subdivided — "instantaneous" readings.
- Oversize drum increases winding speed. Long handle gives extra leverage, locks line at any point.
- Substantial, 4-arm frame has tape roller in each arm. Tape removable from frame.
- Improved pattern finger rings. Patented reinforcing strip prevents kinking and first end breakage.
- Oversize block hook with serrated edges is securely riveted to lip of detachable, swinging ring.
- In 100 ft., 150 ft. and 200 ft. lengths marked feet, 10ths, and 100ths.

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For more information on items described here in brief, use the handy reply card and circle the corresponding numbers

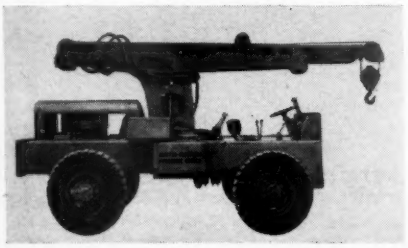
(1) STEEL FITTINGS

The manufacture of 150 lb stainless steel pipe fittings is announced by the Watson-Stillman fittings division, H. K. Porter Company, Inc. The new fittings, designed for standard pressure services where corrosion is a factor, are available in screw-end and socket-welding types in stainless steel type 304 and type 316.

Circle number (1) on reply card.

(2) HYDRAULIC CRANE

Austin-Western Company is manufacturing a new indoor-outdoor hydraulic crane said to combine the best features of crawler, truck and erection cranes with those of industrial shop cranes. Self-propelled, the crane involves four functions: Turntable rotation, boom elevation, raising and lowering of cable and hook, and power extension and retraction of the boom.



Circle number (2) on reply card.

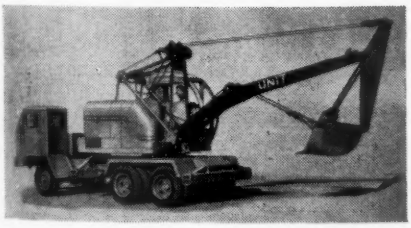
(3) CLAMSHELL BUCKET

A new ⅜-yd clamshell bucket, which uses two hydraulically operated rams instead of a single center ram to handle bowl action, has been developed by Bucyrus-Erie Company for use with its truck-mounted, all-hydraulic H-3 Hydrocrane. The new bucket has been designed to step up the Hydrocrane's digging output.

Circle number (3) on reply card.

(4) UNIT CHALLENGER

The Unit Crane & Shovel Corporation, announces the addition of a new ⅜-yd Unit Challenger model 510 to its line of equipment. This model embodies the features of: Hydraulic clutch control—full floating trunnion-mounted tapered drums—self-aligning hook shoes, force feed lubrication, interchangeability of parts, full range vision safety cab, powered by a Ford heavy-duty engine with torque converter.



Circle number (4) on reply card.

(5) ADAPTER COUPLING

A new corrosion-resistant line pipe adaptor coupling, designed to reduce field inventories while increasing installation convenience, has just been introduced by Johnson-Fagg Engineering Company. The Little Giant adaptor coupling is easily installed and dismantled.

Circle number (5) on reply card.

(6) WRAPPING MACHINE

Remco Manufacturing Company has introduced a new type of power-driven tape wrapping machine. Said to be the first power-driven tape wrapping machine ever manufactured for commercial use, it is light and compact.

Circle number (6) on reply card.

(7) CONDENSER CLEANER

Thomas C. Wilson, Inc., has placed on the market a Blo-Gun condenser cleaner. The air or water operated cleaner is useful for removing soft deposits, such as mud, algae, and similar accumulations.

Circle number (7) on reply card.

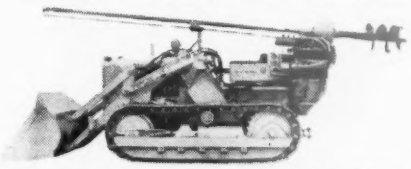
(8) BUTTERFLY VALVE

Mudco O-Ring butterfly valves are now available with grooved ends in 2, 3 and 4-in. sizes for use with grooved type couplings. This new valve is designed to provide a faster, easier method of coupling pipe.

Circle number (8) on reply card.

(10) CRAWLER ATTACHMENT

Allis-Chalmers Manufacturing Company, tractor division, has added model YT earth drill to the line of matched attachments for its 50 hp HD-5 crawler tractor. The new heavy-duty drill has been designed for use along with other front-mounted attachments for the HD-5, and is mounted without disturbing either front-mounted shovel or dozer already on the tractor.



Circle number (10) on reply card.

(11) WINDOW MILLING

Windows milled through casing or liners can now be readily milled and either drainholes or new production holes drilled through the windows as a result of equipment and techniques developed by the Oilwell Drainhole Drilling Company. This new application of ODDCO's high angle whipstock flexible drilling equipment now provides an economical method for obtaining increased production in older wells in which the liners cannot be pulled or where the casing is set through the production zone.

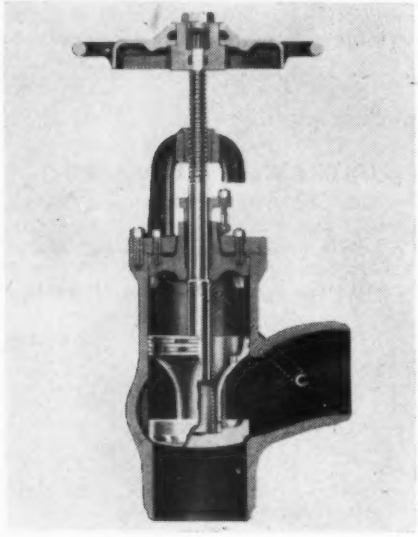
Circle number (11) on reply card.

(9) OPERATOR IS USING a power tong with Martin-Decker indicating gage and remote-reading strip-chart recorder. The gage shows the actual number of foot-pounds of torque being applied. It has a second pointer that the tong man can set as target at the established make-up torque. Circle number (9) on reply card.

New Equipment

(12) VALVES

Improved internal streamlining designed to lessen wear and reduce pressure drop is featured in the new redesigned 600-lb line of Rockwell-built Edward



globe and angle stop, check and nonreturn cast steel valves now being built by Edward Valves, Inc. Features formerly available only in Edward 900-lb, 1500-lb, and 2500-lb valves, are now incorporated into the new 600-lb valves.

Circle number (12) on reply card.

(13) PUSH BUTTONS

Heavy-duty "Oil-Tite" pushbutton stations available from the Westinghouse Electric Corporation can now be equipped with three new accessories. Available are flexible neoprene caps that attach over unshrouded pushbuttons; a new full stroke "Select-O-Push" operator that teams up with a double-pole contact block to make one compact unit to replace the two previously single-pole double-throw units; and a new lever operator for two-unit pushbutton stations that permits precise operation whenever heavy gloves worn by operators could cause faulty selection of pushbutton.

Circle number (13) on reply card.

(14) PLUG INJECTION

Well Controls, Inc., has developed a paraffin control plug injector. Installed on the flow line at the well head the injector permits insertion of paraffin control plugs without interrupting normal flow so as to avoid shut-down or use of auxiliary bypass line.

Circle number (14) on reply card.

(15) VISE STAND

A new Pipemaster tripod vise stand was designed by Erie Tool Works to adjust automatically on pipe from ⅛ to 2½ in., and to clamp on it with less than one turn of the screw. Another feature is the 3-way, long tool-steel top jaw with milled teeth to give triple jaw life. The bottom jaws are reversible.

Circle number (15) on reply card.

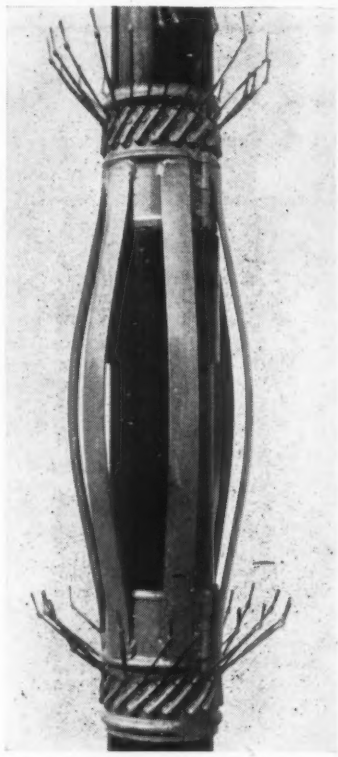
(16) INDICATORS

Jerguson Gage & Valve Company has developed a line of sight flow indicators. Designed for viewing liquid flow, the indicators can be installed in any new or existing pipe line ½ to 2 in. N.P.T.

Circle number (16) on reply card.

(17) SCRATCHALIZERS

B and W Latch-On Scratchalizers, multi-flex type, have been redesigned to include new features. The centralizer unit



includes B and W Kon-Kave bows, and triple heat treatment protects these alloy spring steel bows against breakage.

Circle number (17) on reply card.

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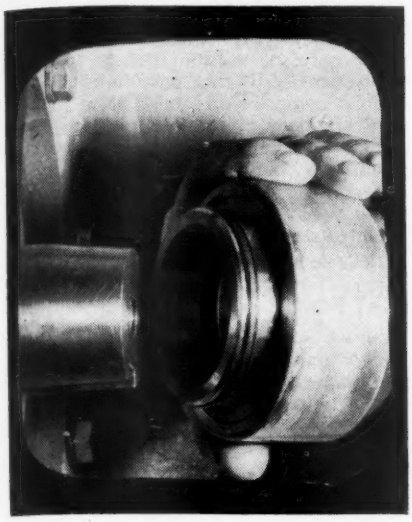
(18) ROTARY SEAL CARTRIDGE

A new rotary mechanical shaft seal in an easily-replaceable cartridge assembly has been announced by Mixing Equipment Company, Inc. This seal has been



designed especially for service in fluid mixing applications. It is now available, in either single or double types, on all models of Lightnin Mixers where shaft sealing is required, and in a variety of materials.

Circle number (18) on reply card.

(19) TEFLON YARN

A new Teflon yarn packing designed to function at higher peripheral speeds than ordinary braided tape or molded forms of Teflon has been developed. The anti-frictional properties of Teflon combined with the softness, resilience and fluid retentive properties of fine fiber construction enables the packing to run substantially cooler than other types, Crane Packing Company said.

Circle number (19) on reply card.

(20) VINYL COATING

A new vinyl mastic protective coating that need be applied in only one coat to combat corrosion has been developed by Amercoat Corporation. The new coating, Amercoat No. 87, can be applied at a thickness of 10 mils in one double-pass spray coat.

Circle number (20) on reply card.

(21) D7 TRACTOR

Increased horsepower and engine speed highlight engineering improvements that have been introduced in the new D7 track-type tractor announced by Caterpillar Tractor Company. The engine in this tractor has 128 hp at 1200 rpm compared to the 108 hp at 1000 rpm in the previous model. The maximum draw-bar pull for the D7 is now 28,700 lb, approximately 3500 lb pull more than its predecessor.

Circle number (21) on reply card.

(22) THERMOPILOT RELAY

A thermopilot relay for automatic safety shutoff of gas-fired appliances has just been placed on the market by General Controls Company. The new unit, known as the A-100R, features automatic reset and exceedingly stable operation.

Circle number (22) on reply card.

(23) MODEL K160R

A new development in the Kohler Company air-cooled engine line is model K160R. The engine is equipped with a reduction unit providing a 6:1 reduction gear ratio for applications requiring low power-take-off speeds. Clockwise or counter clockwise crankshaft rotations are available.

Circle number (23) on reply card.

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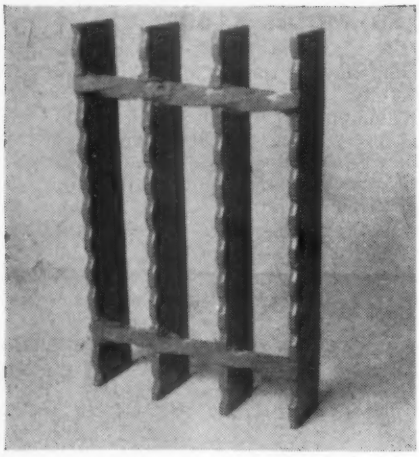

(24) STEEL GRATING

A new type of electroforged steel grating has been announced by the grating department, Blaw-Knox Company. It is designed for areas where walking conditions are hazardous. To achieve an extra margin of safety the bearing bars have mill-rolled serrated edges. This provides an excellent traction surface with comfortable walking conditions. The crossbars are of twisted steel, as illustrated.

Circle number (24) on reply card.

(25) DUAL CHRISTMAS TREE

Oil Center Tool Company is now producing a dual Christmas tree for use in dual well completions which was designed to provide a substantial saving in drilling and equipment costs. In developing this dual tree O-C-T has included such features as a special hanging and sealing flange on top of the tubing head and steel-to-steel seals throughout the assembly through using Flex-Float steel rings.

Circle number (25) on reply card.

(26) COMPRESSOR PUMP

A new line of two-stage 100-lb rotary air compressor/vacuum pumps for shop air systems, drill rigs, pneumatic conveyors, gas compression, and similar applications has been announced by Allis-Chalmers Manufacturing Company. The new compressor/vacuum pump is water cooled and consists of a separate low pressure unit coupled to a high pressure unit, both mounted on a common bed plate.

Circle number (26) on reply card.

(27) HD-21 TRACTOR

Allis-Chalmers Manufacturing Company is manufacturing a new HD-21 tractor designed for jobs that require more power, longer life and the ability to operate at a lower cost per unit of work. The tractor weighs 44,000 lb, develops 204 hp at the flywheel and will offer the high-output torque converter drive as standard equipment.

Circle number (27) on reply card.

(28) MOTOR SCRAPER

A new motor scraper, the TS-360, is now in production by Allis-Chalmers Manufacturing Company. According to announcements, tests of the new rubber-tired giant indicate that it establishes a new high in dirt-moving ability. The motor scraper, weighing 49,000 lb, has 15-cu-yd struck capacity, 20-cu-yd heaped capacity and features a new 280-hp Allis-Chalmers diesel engine.

Circle number (28) on reply card.

(29) JOINT WRAP

A new joint wrap for underground pipe lines is being marketed under the tradename "Duratape" by Glass Fibers, Inc. Designed as a tough, long-lasting dielectric barrier against corrosion, the new wrap is particularly suitable for hand-wrapping field joints and fittings on oil and gas transmission and distribution lines.

Circle number (29) on reply card.

(30) SAFETY FLOOR ARMOR

Announcement of a new Hexteel safety floor armor that has less weight per square foot and a greater exposed steel surface has been made by Klemp Metal Grating Corporation. Hexteel was developed for resurfacing existing concrete or wood floors.

Circle number (30) on reply card.

(31) LINE-UP CLAMP

Cinch Pipeline Equipment Company is manufacturing a new pipe line-up clamp which is said to practically eliminate sledging. It was designed to operate in any position in tie-in, fabrication, and construction jobs.

Circle number (31) on reply card.

(32) TRACTAIR

Le Roi division, Westinghouse Air Brake Company has increased the air output of its Tractair from 105 to 125 cfm. The Tractair is a combination 125 cfm air compressor and a 35 hp wheeled tractor designed primarily to bring compressed air power to otherwise hard-to-get places.

Circle number (32) on reply card.

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Falmouth, Mass.—Walter S. Bennett, 53 Minot St.
Houston, Tex.—Henry H. Paris Distributor, Inc., Box 932
Los Angeles, Cal.—James A. Riordan Co., 1400 Santa Fe Avenue
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Narberth, Pa.—J. W. Worthington, 105 Forrest Ave.
Newark, N. J.—Ira L. Rothenberg & Assocs., 69 Lincoln Park
New York, N. Y.—Max Rothenberg, 11-05 38th Ave., Long Island City
Portland, Ore.—Earl H. Jones & Co., 1233 NW 12th Ave.
Richmond, Va.—P. C. Abbott & Co., 15 E. Franklin St.
St. Louis, Mo.—Mike A. Boyle Co., 1112-18 Hamilton Ave.
San Francisco, Cal.—Earl H. Jones & Co., 1150 Folsom St.
Seattle, Wash.—Earl H. Jones & Co., 819 Thomas St.

WHEELING MACHINE
PRODUCTS COMPANY
WHEELING, WEST VIRGINIA
Factories at WHEELING, W. VA.
and WOODLAKE, CALIFORNIA

(33) PIPE WRENCHES

The Roddick Tool Company, of Anaheim, California, has just announced that its larger sizes of internal pipe wrenches, sizes 2½ through 4 in., are again available. The wrenches are available in pipe sizes of from ⅛ through 4 in.

Circle number (33) on reply card.

(34) CROWN BLOCKS

A new line of smaller crown blocks has been announced by The National Supply Company. Known as the type E Crown blocks, they are intended to match up with the type E traveling blocks and type E hook-blocks, and have matching sheaves.

Circle number (34) on reply card.

(35) TRANSISTOR MOTOR

The General Electric Company's small integral motor department has announced a new transition polyphase motor line in the 1 to 5 hp range. To be built in the old frame sizes and dimensions of the National Electrical Manufacturers Association, the motors will incorporate the engineering and insulation features of the Tri-Clad 55 motor.

Circle number (35) on reply card.

(36) PANEL INSTRUMENTS

A new line of core-magnet, self-shielded panel instruments in the popular 3½ in. size, has been introduced by the Weston Electrical Instrument Corporation. Known as the 1301 line, these instruments are available for d-c or as a-c rectifier type instruments in both round and rectangular shapes.

Circle number (36) on reply card.

(37) HEAT EXCHANGER FANS

Plastic-impregnated wood blades are now available on 14- to 22-ft heat exchanger fans manufactured by the Hartzell Propeller Fan Company. Hartzite plastic blades are still recommended by the company for maximum durability and length of life, but the initial cost of the plastic-impregnated wood blades is considerably lower.

Circle number (37) on reply card.

(38) MEASURING TAPE

Long, steel tapes have been added to the line of White Clad tapes and tape rules by The Lufkin Rule Company. This new tape, called the White Clad Banner, is furnished in four lengths, 25, 50, 75 and 100 ft.

Circle number (38) on reply card.

(39) FEED CONTROL UNIT

Graver Water Conditioning Company has announced a complete chemical feed control apparatus in a small high-visibility package. Combining precise control with a liquid level alarm, this new unit is designed to regulate flow in any situation in which it is necessary to feed liquid chemicals.

Circle number (39) on reply card.

(40) TANK CLEANER

A new tank cleaner providing three-dimensional rotation of a high pressure hydraulic jet has been announced by the Sellers Injector Corporation. Designated as the rotor jet, it delivers two streams of hot or cold water, with or without detergents, over entire inside tank surface.

Circle number (40) on reply card.

He turns

Waste into Profit

with BREAXIT

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Sales Technical Service Division
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NEW oil and gas Literature

- Brochures
- Bulletins
- Catalogs

For more information on items described here in brief, use the handy reply card and circle the corresponding numbers

(41) HYDRAULIC CRANE

Austin-Western Company has released Hydraulic Crane Bulletin AD-2253 covering performance of its new indoor-outdoor hydraulic crane. Crane has such features as 360 deg boom rotation, 24-ft horizontal reach from center of rotation, 24 ft vertical lift from ground level to hook, ability to negotiate grades up to 20 per cent under full load and 15 mph road speed under full load.

Circle number (41) on reply card.

(42) FLOW TRANSMITTER

The Mag/Nu/Matic, a magnetically actuated pneumatic transmitter designed for use with all types of pneumatic receivers and control instruments, is described in Bulletin No. 170, from Brooks Rotameter Company. The transmitter which has only three moving parts, employs a force-balance pneumatic system requiring a minimum of mechanical motion, resulting in low inertia characteristics and improved response time.

Circle number (42) on reply card.

(43) AIR REDUCTION

Air Reduction Sales Company is offering a 36-page catalog covering its line of arcwelding and oxyacetylene welding supplies and accessories. Included are welding rods, fluxes, brazing alloys, goggles, helmets, shields, electrode holders, protective clothing, cable, clamps, hose, lighters, cylinder trucks, and carrying cases.

Circle number (43) on reply card.

(44) LINE TUBING

Spang extreme line, integral joint, oil well tubing in seven sizes and three grades is described in a colorful 8-page bulletin, No. 414, by Spang-Chalfant division of The National Supply Company. Also included are recommended practices for running and pulling tubing.

Circle number (44) on reply card.

(45) SAFETY VALVES

Crosby Steam Case and Valves Company has published a 16-page color brochure with photographs illustrating the flow pattern through Crosby HC safety valve passages. Brochure was planned especially for those concerned with the use of steam above 1000 psi. Complete design information plus data on saturated steam capacities, superheat correction factors, and valve material specifications are given.

Circle number (45) on reply card.

(46) PACKING, PISTON RINGS

Bulletin No. 500 published by C. Lee Cook Company describes its Cookroc (laminated Bakelite) packing and piston rings. Four-page bulletin covers specifications and physical properties of Cookroc and indicated uses.

Circle number (46) on reply card.

(47) OIC VALVES

The Ohio Injector Company has published Forms No. 1001 and 1002 covering 200-lb OIC bronze valves and valves for control of L-P gas. Form 1001 discusses glove and angle valves, horizontal and angle checks and modern long line valves. Form 1002 discusses valves for the L-P gas industry, giving applications and specifications.

Circle number (47) on reply card.

(48) LIQUID RECEIVERS

Bulletin LR-1, published by Henry Vogt Machine Company, describes the use of Vogt liquid receivers for ammonia and freon. Complete specifications of Vogt products are given, illustrated by drawings and photographs.

Circle number (48) on reply card.

(49) POWER PIPING

Specific services and facilities offered to the utility power piping field, including methods of stress analysis, metallurgical research, new welding methods, and special heat treatment techniques, are described in a 12-page booklet published by the fabricated products division of The M. W. Kellogg Company.

Circle number (49) on reply card.

(50) DIAMOND DRILLING

The Hillmac Corporation has published a brochure describing new ideas in engineered diamond drilling. Information on selection and application of Hillmac products is given, illustrated by drawings and photographs.

Circle number (50) on reply card.

(51) SANDFRAC TREATMENT

Dowell Incorporated publishes The Acidizer, sheet describing the use of high-injection-rate Sandfrac treatment to increase oil production. Example problems, methods, and results are given.

Circle number (51) on reply card.

(52) STRIPPER PRODUCTION

The S. C. Carter Company, Inc., has published Bulletin PR-355 discussing stripper well production through long-stroke variable-cycle pumping. Operating advantages and complete specifications for the Carter hydraulic pumping units are given.

Circle number (52) on reply card.

(53) PVC VALVES

A completely illustrated, four-page circular describing Luncor, the first all molded PVC valve and fittings, has been published by The Lunkenheimer Company. An exclusive molding process is said to give the PVC material exceptional strength, protect its natural corrosion-resistance, and substantially reduce manufacturing costs.

Circle number (53) on reply card.

(54) NEW BOILER MODELS

A new 4-page brochure, AD-137, covering the LR and CB models of self-contained boilers has been announced by the Cleaver-Brooks Company. Compactness in design is illustrated in addition to listing advantages of these units. Suggested boiler room layout and dimensions are included.

Circle number (54) on reply card.

(55) BLOWERS

Complete, dimensions, specifications and performance data on Hartzell's new non-overloading utility blowers with backward curved blades is presented in a new bulletin, BC-11, issued by the Hartzwell Propeller Fan Company. Data given for the complete line which includes 12¼- to 36½-in. belt drive blowers, 12¼- to 33-in. direct-drive models, 12¼- to 36½-in. arrangement 2 blowers; 24½-in. to 49-in. arrangement 3 single width, single inlet blowers and 12¼- to 49-in. arrangement 3 double width, double inlet blowers.

Circle number (55) on reply card.

(56) PIPE FITTINGS

The new 150 lb stainless steel pipe fittings recently announced by Watson-Stillman fittings division, H. K. Porter Company, Inc. are described in Bulletin S-3-55. Fittings manufactured in the new line include 90 deg elbows, tees, 45 deg elbows, crosses, couplings, reducers, pipe caps, unions, plugs, and bushings . . . available in Type 304 and 316 stainless steel.

Circle number (56) on reply card.

(57) DR DIESEL ENGINES

Worthington Corportion has issued a a new bulletin which describes DR diesel engines. These units are used in municipal power plants, water works, sewage treatment plants, radio broadcasting stations, pipeline pumping stations and in many similar applications where power is required. Bulletin explains the operation of these diesel engines.

Circle number (57) on reply card.

(58) DESULFURIZERS

Black, Sivalls & Bryson, Inc., has published Catalog 36-01 on amine-type desulfurizers. Designed for economical production of "sour" gas wells, BS&B's amine-type desulfurizer is available in a wide range of sizes—from small compact units skid-mounted regeneration systems to large capacity systems for central plant installation.

Circle number (58) on reply card.

(59) RUBBER

E. I. Du Pont de Nemours and Company is publishing Neoprene Notebook discussing the thermal properties of rubber. The paper also gives examples of Neoprene products' uses in industry.

Circle number (59) on reply card.

(60) PRODELIN

Prodelin, Inc., is offering a new 1955 32-page price list, which lists microwave relay, antenna system components and every thing manufactured by Prodelin under one cover. The new list features complete product descriptions suitable for ordering purposes, and a cross reference ordering purposes, and a cross reference.

Circle number (60) on reply card.

(61) MIXERS

Eastern Industries, Inc., has released a new portable mixer catalog, Bulletin 520-P. This new 16-page bulletin provides product information, and engineering information, data, and diagrams. Among the units described are 420, 1125 and 1725 rpm mixers, variable speed mixers, air-driven mixers, and accessories to solve special problems.

Circle number (61) on reply card.

(62) WATER RECLAMATION

Technical Reprint T-129, which discusses the Treatment of Sewage Plant Effluent for Water Reuse in Process and Boiler Feed, is now available from Graver Water Conditioning Company. Fully documented and illustrated, this article examines current developments and design factors in the use of this source of water.

Circle number (62) on reply card.

(63) VOLUME PUMP

A new 4-page two-color bulletin describes the new Lapp Microflo Pulsafeeder pump. A new piston-diaphragm pump, it is described as operating against pressures up to 1000 psi and has a maximum flow rate of 2400 ml per hr.

Circle number (63) on reply card.

(64) NI-RESIST

Revised edition of Bulletin A-71, Engineering Properties and Applications of Ni-Resist, released by The International Nickel Company, features applications of Ni-Resist, corrosion-resistant nickel alloyed cast iron, in nine specific industries as well as in general industrial uses.

Circle number (64) on reply card.

(65) VOLTMETERS

Non-Linear Systems, Inc., has published Bulletin No. 150 on digital voltmeters for measuring direct current voltages automatieally. Standard series specifications are given as well as individual specifications. Bulletin is supplement to Bulletin No. 100.

Circle number (65) on reply card.

(66) HOSE, FITTINGS

A new composite industrial products catalog has been issued by The Weatherhead Company, Cleveland, Ohio. Known as the Weatherhead "Yellow Book," it contains 132 pages of informtaion on industrial hose and fittings for designers of hydraulic and pneumatic control systems.

Circle number (66) on reply card.

(67) FOAMGLAS

A new brochure, available from the Pittsburgh Corning Corporation, features information on how the use of Foamglas cellular glass insulation solved the severe insulating problems of leading users. The illustrated brochure shows application of Foamglas to insulate roofs, ceilings, walls, and floors of all kinds of buildings, cold storage spaces, piping, tanks and equipment.

Circle number (67) on reply card.

(68) TRUCK PUMP

The Blackmer Pump Company's new Gold Seal rotary truck pump which is designed for handling petroleum products and especially aromatic aviation fuels and solvents, is described in a four page specification sheet. Designated as Specification Sheet 200-C, this piece describes features, construction details and general dimensions as well as a selection chart.

Circle number (68) on reply card.

(69) HOSE CHECK LIST

A new hose check list giving tips on obtaining longer hose life and better performance is offered by the Thermoid Company. Printed in black on a yellow background for easy reading, the eleven-point check list highlights four common abuses of hose with drawings. A chart of stiff cardboard is designed for wall mounting in plant areas where hose is used. It is lacquered for protection against moisture, oil, grease, and dirt.

Circle number (69) on reply card.

(70) NGAA TABLE

The Natural Gasoline Association of America has announced the publication of a revised edition of its publication 2145, "Physical Constants for the Paraffin Hydrocarbons and other Components Associated with Natural Gas."

Circle number (70) on reply card.

(71) TURBINE GENERATORS

General Electric Company turbine-generators, rated from 2500 kw to 40,000 kw, are described in a new booklet designated GEA-3277C. Condensing and non-condensing applications for electric utilities and industrial plants as well as special turbine applications are covered in detail in the new publication.

Circle number (71) on reply card.

(72) DRILLING RIG

The Ideal Type 130 Consolidated drilling rig is described in Bulletin No. 434 by The National Supply Company. The 20-page booklet includes improvements developed since this 1300-hp deep drilling rig was introduced several years ago.

Circle number (72) on reply card.

(73) TORQUE CONVERTERS

An eight-page, four-color catalog describing Clark Equipment Company's line of torcon torque converters is available. Extensively illustrated, the brochure depicts models, shows attachments for specific adaptations, and describes, with cutaway drawings, construction of the converters.

Circle number (73) on reply card.

(74) ENGINE DEVELOPMENT

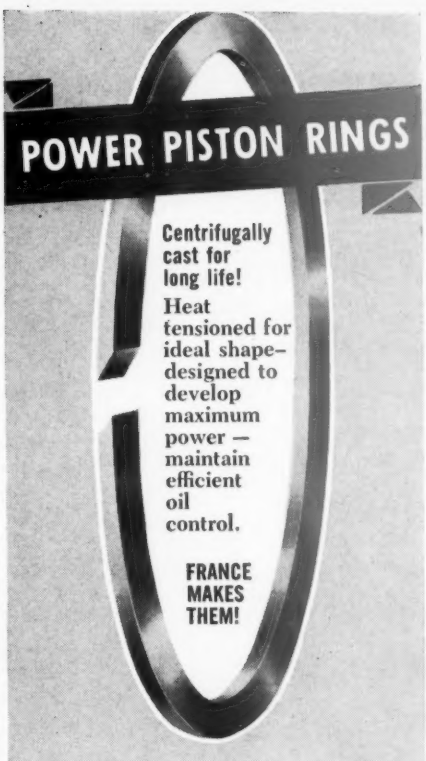
"The saga of the piston . . . or 274 years from toy to titan" is the lead article in the Production Road magazine, just released by Twin Disc Clutch Company. The article covers the full sweep of internal combustion engine development, from the Huygen engine of 1680 up to the powerful gas and diesel engines of today.

Circle number (74) on reply card.

(75) CATALYST CARRIERS

Celite Catalyst Carriers is the title of a new 4-page folder issued by Johns-Manville. It describes the advantages of Celite diatomite catalyst carriers, giving essential data on each type in tabular form.

Circle number (75) on reply card.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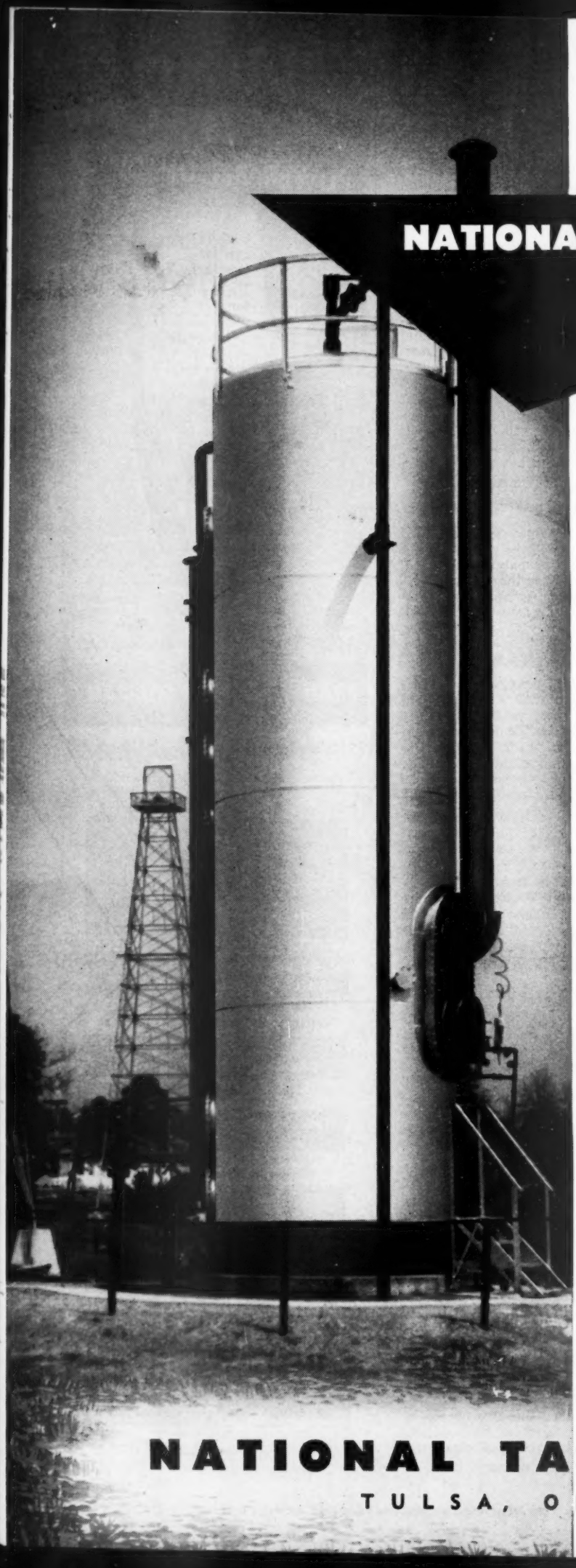

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$731.64 PER MONTH

Inter-Office Correspondence

To: [redacted] Date: April [redacted]

Subject: National ICP Treater
installed on our [redacted] Lease.

Dear Bud:

We thought you might be interested to know of the results obtained from the installation of the ICP Treater on our [redacted] Lease last September.

In figuring the amount of gas purchased for this lease, taking months comparable in weather conditions, six months before and six months after the installation, we find that in the preceding six months we bought gas in the amount of $1,298.99 and in the succeeding six months we purchased gas in the amount of $599.47 a total saving for six months of approximately $699.47 or $133.00 per month.

Before installing this Treater it was necessary that we clean ten tanks per month, losing approximately twenty barrels of oil each time. This would amount to 200 barrels per month or approximately $486.00 per month. This Treater has now been in service approximately eight months and we have not cleaned a single tank.

In addition to the gas and tank cleaning saving we also raised the gravity of the oil an average of 1°, which raised the price of the oil .02¢ per barrel. As this lease averaged 5,632 barrels of oil per month after installation of the Treater the amount gained on raising the gravity amounted to $112.64 per month.

We figure the total savings as follows:

$133.00 per month saving on gas.
$486.00 worth of oil saved each month.
$112.64 more per month for increased gravity.
$731.64 Total saving each month.

The first six months after installing this Treater we had saved $4,395.84. As the Treater cost $3,439.26, at the expiration of six months the Treater was paid for with $956.58 left over as profit.

Respectfully yours,

[redacted]

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TULSA, OKLAHOMA

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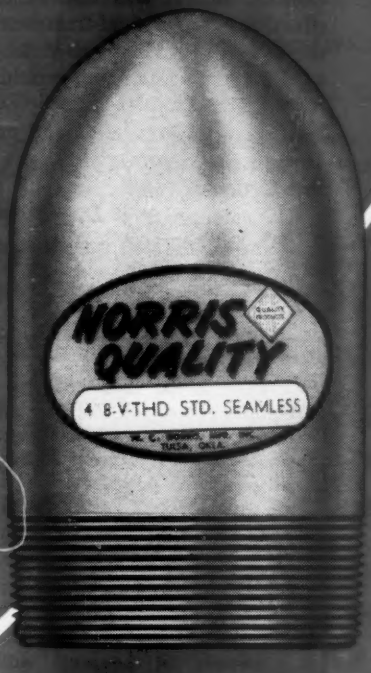

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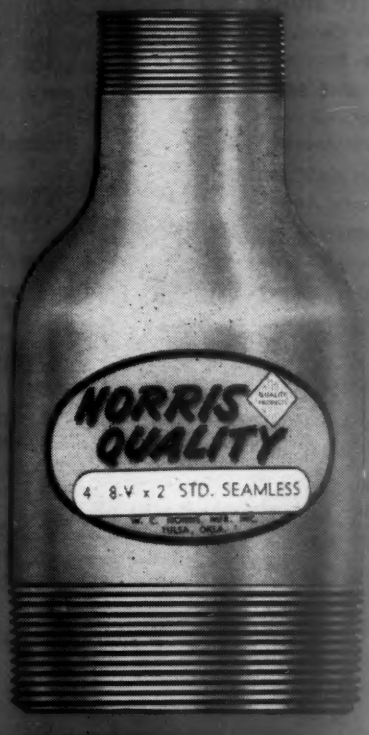

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LETTERS

Everybody Wants Indexes

As I have *The Petroleum Engineer* since 1949 . . . would you be so kind as to send me the indexes for the years 1949 to 1954 inclusive.

Dr. J. Schmidt.

Firma Carl Still
Reckinghausen i. Westf.
West Germany

★ ★ ★

I would appreciate receiving a copy of the editorial index to *The Petroleum Engineer* during 1954.

Sam J. Morris, Jr.

District Superintendent
Barron Kidd
Sistersville, West Virginia

★ ★ ★

The writer would appreciate a copy of the 1952 and 1954 indexes to the magazine. In my file I already have a copy of the 1953 index and have found it quite useful. Other engineers within the company also refer to this index from time to time.

W. F. Moore.

Engineering Department
Universal Oil Products Company
Des Plaines, Illinois

★ ★ ★

. . . Send me two copies of your editorial index for 1954.

C. B. Lester.

Chief Engineer
Mid-Valley Pipeline Company

★ ★ ★

. . . Would appreciate receiving a copy of the index to all articles published in *The Petroleum Engineer* during 1954.

P. J. Ruckel.

Senior Technologist
Continental Oil Company
Denver, Colorado

★ ★ ★

Supply us with copies of the index of articles published in *The Petroleum Engineer* in 1954 . . .

O. Gomez Rivero.

Coatzacoalcos, Mexico

★ ★ ★

Would you please send me two copies of the annual index . . .

V. E. Bohme.

Petroleum and Natural Gas
Conservation Board
Edmonton, Alberta, Canada

Note: *From Amsterdam to Casper, Wyoming have come hundreds of requests for our annual index of editorial articles. By checking the proper item on the handy business reply card on page E-41, you may receive your copy.*

Article Has Overall Appeal

If they are available, I would very much appreciate receiving a reprint of the article "Calculation of the Flow and Storage of Natural Gas in Pipe," by R. G. Nisle and Fred H. Poettmann, appearing in the Pipelining section of your January 1955 issue with tables in the February and March issues. I am a subscriber to the Drilling and Producing edition which covers my interests well; however, the requested article contains information of such a basic, useful nature that it has applications in any work connected with natural gas. You are to be congratulated on the many excellent technical articles such as this published in your magazine.

Philip W. Reed

The Pennsylvania State University
University Park, Pennsylvania

'Public Relations' Practical

We greatly admired the fine article in your April, 1955, issue by Gene Graham, entitled "Good Public Relations Should Begin With the Drilling Contractor." It was one of the most effective and practical treatments of the subject we have seen to date. In fact, we like it so much we would like to run off some copies by lithograph and send them to our clients and prospects. May we have your publisher's permission to do so?

J. D. Rittenhouse

Rittenhouse & Company, Inc.
Houston, Texas

CREED

Here is the creed of one great company and we believe most oil and gas firms try to live up to similar high standards. Below is the statement of policy reprinted from the annual report of Union Oil Company of California. The eighth annual report survey begins on Page A-63.

Union Oil Company believes in —

- Paying fair dividends to share owners in keeping with the growth of their equity in the company
- Giving highest product and service to its customers
- Providing fair pay, security and opportunities to employees
- Paying a just share of taxes to the Government
- Contributing its best efforts toward the maintenance of a free and prosperous economy